

THE SIDEREAL MESSENGER,

CONDUCTED BY WM. W. PAYNE.

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WHOLE No. 86

PROFESSOR ELIAS LOOMIS.*

Elias Loomis was born in the little hamlet of Willington, Conn., August 7th, 1811. His father, the Rev. Hubbell Loomis, was pastor in that country parish from 1804 to 1828. He was a man possessed of considerable scholarship, of positive convictions, and of a willingness to follow at all hazards wherever truth and duty, as he conceived them, might lead. He had studied at Union College, in the class of 1799, though apparently he did not finish the college course with his class. He is enrolled with that class in Union College, and he also received, in 1812, the honorary degree of Master of Arts from Yale College. At a later date he went to Illinois, and there was instrumental in founding the institution which afterwards became Shurtleff College.

Although the boy inherited from his father a mathematical taste, yet his love for the languages also was shown at a very early age. At an age at which many bright boys are still struggling with the reading of English, he is reported to have been reading with ease the New Testament in the original Greek. He prepared for college almost entirely under the instruction of his father. He was, for a single winter only, at the Academy at Monson, Mass. Owing in part to feeble health he was more disposed, in those early years, to keep to his books than to roam with other boys over the Willington hills. In his later life he frequently said that in his early days he never had a thought of asking what subjects he was most fond of, but studied what he was told to study.

At the age of fourteen he was examined and was admitted to Yale College, but owing to feeble health he waited an-

* An extract from a memorial address prepared by Professor H. A. Newton and delivered in Osborne Hall April 11, 1890, at the request of the President and Fellows of Yale University.

other year before actually entering a class. In college he appears to have been about equally proficient in all of the studies, taking good rank as a scholar, and maintaining it through his college course. President Porter remembers well the retiring demeanor of the young student, and his concise and often monosyllabic expressions, peculiarities which he retained through life. During his Junior and Senior years he roomed with Alfred E. Perkins, whose bequest was the first large endowment of the College Library. He graduated in 1830.

A few weeks before graduation he left New Haven and entered a school, Mount Hope Institute near Baltimore, to teach mathematics, and he remained there for a year and a term. One of his classmates, the late Mr. Cone of Hartford, said that Mr. Loomis had intended to spend his life in teaching, and that it surprised him when he heard that this purpose was abandoned and that Mr. Loomis had gone, in the Autumn of 1831, to the Andover Theological Seminary with the distinct expectation of becoming a preacher. This new purpose was, however, again changed when a year later he was appointed Tutor in Yale College. A vacancy in the Tutorship occurred in the May following (1833) and while not yet twenty-two years of age he returned to New Haven and entered upon the duties of the office. Here he remained for three years and one term. In the spring of 1836 he received the appointment to the chair of Mathematics and Natural Philosophy in Western Reserve College, at Hudson, Ohio. He was allowed to spend the first year in Europe. He was therefore, during the larger part of the year 1836-7, in Paris attending the lectures of Biot, Poisson, Arago, Dulong, Pouillet and others. He did not visit Germany because of want of money. A long series of letters written by him at this time appeared in the *Ohio Observer*, and the contrast between England and France as he saw them, and the same places as seen by the tourist to-day is decidedly interesting.

He purchased in London and Paris apparatus for his professorship, and the outfit for a small Observatory, and in the Autumn of 1837 began his labors at Hudson. Here he remained for seven years, maintaining with unflagging perseverance both his work in teaching and his scientific labors. In judging of this work at Hudson we must remember that

he was not with perfect surroundings. He was without an assistant and without the counsel and encouragement of associates in his own branches of science. The financial troubles which culminated in this country in 1837 were peculiarly severe upon the young and struggling College. Money was almost unknown in business circles in Ohio, trade being almost entirely in barter. In this way principally was paid so much of the promised salary of \$600 per annum as was not in arrears. In one of his letters he congratulates himself that all of his bills that were more than two years old had been paid. In another he says that there was not enough money in the College treasury to take him out of the state. When he left Hudson the College offered to pay at once the arrears of his salary by deeding to him some of its unimproved lands.

In 1844 he was offered, and he accepted, the office of Professor of Mathematics and Natural Philosophy in the University of New York. In this new position he undertook the preparation of a series of text books in the Mathematics, and for some years a large part of the time which he could spare from his regular college work was given to the preparation of these books.

When Professor Henry resigned his professorship at Princeton in order to accept the office of Secretary of the Smithsonian Institution, Professor Loomis was offered the vacant chair. He went to Princeton and remained there during one year, at the end of which he was induced to return again to his old place in the University of New York. Here he continued until 1860, when he was elected to the Professorship in Yale College made vacant by the death of Professor Olmsted. For the last twenty-nine years of his life, he here labored for the College and for science, passing away on the 15th of August, 1889.

Let us look now in succession at the different lines of his activity during these fifty-six years,—four here in the tutorship and in Europe; seven at Hudson, Ohio; sixteen in New York City and Princeton, and twenty-nine in New Haven.

For the first year on returning from Andover to New Haven, he was tutor in Latin, although it seems that he might, had he chosen it, have been tutor of Mathematics. I believe that at the beginning his mind was not yet definite-

ly turned towards the exact sciences. In his childhood he had taken specially to Greek. In college he was equally proficient in all of his studies. He is represented to have led his class at Andover in Hebrew, and now on entering the tutorship he chose to teach the Latin language and literature. During the second year he taught Mathematics, and the third year Natural Philosophy. His later success in scientific work was, I believe, in no small measure due to his earlier broad and thorough study of language.

I have made some inquiry in order to learn what it was that turned his attention and tastes towards science. One of his colleagues in the tutorship, the Rev. Dr. Davenport, says that he recollects very distinctly the first indication to his own mind that Tutor Loomis was turning his thoughts in this direction. The great meteoric shower of 1833 came early in the period of his tutorship, and the views of Professor Twining and Professor Olmstead about the astronomical character and origin of these interesting and mysterious bodies were a common topic of conversation among scientific men in the College, especially wherever Professor Olmstead was present. The tutors were accustomed to meet as a club from time to time in the tutors' rooms in turn, and Dr. Davenport well recollects the occasion when Tutor Loomis brought in a globe and discussed before the club the new theories about these bodies. Up to this time Tutor Loomis had seemed to him to have given his thoughts and study to language rather than to science.

In January, 1834, there were constituted in the Connecticut Academy of Arts and Sciences twelve committees representing the several departments of knowledge, and Tutor Loomis was put on the Committee on Mathematics and Natural Philosophy. These are the only signs of scientific taste or activity which I have detected earlier than the autumn of 1834, after he had been a year and a term in the tutorship. From this time on to the end of his life, he gave his time and energies to several subjects that are enough distinct one from the other to make it convenient to disregard a strictly chronological account of his labors, and consider his work in each subject by itself.

A subject of which he early undertook the investigation was *Terrestrial Magnetism*. We often use the rhetorical

phrase, "True as the needle to the pole," but looked at carefully, the magnetic needle is anything but constant in direction; like the weather vane on the steeple, it is ever in motion, swinging back and forth, in motions minute and slow, it is true, but still always swinging. It has fitfully irregular motions;—it has motions with a daily period;—motions with an annual period; and motions whose oscillations require centuries for completion.

The *daily* motions of the magnetic needle were those which Tutor Loomis first studied. At the beginning of the second year of his tutorship he set up by the north window of his room in North College a heavy wooden block, and on it the variation compass that belongs to the College. Here for over thirteen months he observed the position of the needle at hourly intervals in the daytime, his observations usually being for seventeen successive hours of each day.

The results of these observations, together with a special discussion of the extraordinary cases of disturbance, were published in the American Journal of Science in 1836. No similar observations of the kind made in this country had at that time been published. So far as I am aware none made before 1834 have since been published, except ten days' observations made by Professor Bache in 1832. In fact, I know of only two like series of hourly observations made in Europe earlier than those by Tutor Loomis. He also at this time formed the purpose of collecting all the observations of magnetic declination that had been hitherto made in the United States, and of constructing from them a magnetic chart of the country. He appealed successfully to the Connecticut Academy of Arts and Sciences for its sympathy and aid. The work of collecting facts was so far advanced before leaving New Haven that when he had been a few months Professor at Hudson he forwarded to the American Journal of Science a discussion of the observations thus far obtained, and with them a map of the United States, with the lines of equal deviation of the needle drawn upon it. Two years later he published additional observations and a revised edition of this map.

These were the first published magnetic charts of the United States, and though the materials for their construction were not numerous, and in many cases those obtainable

were not entirely trustworthy, yet sixteen years later, when a map was made by the United States Coast survey from later and more numerous data Professor Bache declared that between his own new map and that of Professor Loomis, when proper allowance had been made for the secular changes, the "*agreement was remarkable.*"

The northern end of a perfectly balanced magnetic needle turns downward, and the angle it makes with the horizon is called the magnetic *dip*. This angle is an important one, and is observed with accuracy only by using an expensive instrument, and taking unusual pains in observing. Hence only a few observations of this element were found by Professor Loomis. From these, however, he ventured to put on his first magnet map a few lines that exhibited the amount of the *dip*.

While he was in Europe he purchased a first class dipping needle, for Western Reserve College, and at Hudson and the neighborhood in term time, and at other places in vacation, he made observations with this needle. Some of these observations were made before his second magnetic chart was published, and upon this map were now given tolerably good positions of the lines of equal magnetic dip. But he continued his observations for several years, determining the dip at over seventy stations, spread over thirteen states, each determination being the mean of from 160 to over 4,000 readings. These observations were published in several successive papers in the transactions of the American Philosophical Society at Philadelphia.

Various papers on terrestrial magnetism, in continuation of his earlier investigations, appeared in 1842, in 1844, in 1847, and in 1859, but movements in Germany, England and Russia had meanwhile been inaugurated which led to the establishment by governments of a score of well equipped magnetic observatories, and this subject passed largely out of private hands.

Closely connected with terrestrial magnetism, and to be considered with it, is the *Aurora Borealis*. In the week that covered the end of August and the beginning of September, 1859, there occurred an exceedingly brilliant display of the Northern lights. Believing that an exhaustive discussion of a single aurora promised to do more for the promotion of

science than an imperfect study of an indefinite number of them, Professor Loomis undertook at once to collect and to collate accounts of this display. A large number of such accounts were secured from North America, from Europe, from Asia, and from places in the Southern Hemisphere; especially all the reports from the Smithsonian observers and correspondents, were placed in his hands by the Secretary, Professor Henry.

These observations and the discussions of them were given to the public during the following two years, in a series of nine papers in the *American Journal of Science*.

Few, if any, displays on record were as remarkable as was this one for brilliancy or for geographical extent. Certainly about no aurora have there been collected so many facts. The display continued for a week. The luminous region entirely encircled the North Pole of the earth. It extended on this continent on the 2d of September as far south as Cuba, and to an unknown distance to the north. In altitude the bases of the columns of light were about fifty miles above the earth's surface, and the streamers shot up at times to a height of five hundred miles. Thus over a broad belt on both continents this large region above the lower atmosphere was filled with masses of luminous material. A display similar to this, and possibly of equal brilliancy, was at the same time witnessed in the Southern Hemisphere.

The nine papers were mainly devoted to the statements of observers. Professor Loomis, however, went on to collect facts about other auroras, and to make inductinos from the whole of the material thus brought together. He showed that there was good reason for believing that not only was this display represented by a corresponding one in the Southern Hemisphere, but that all remarkable displays in either hemisphere are accompanied by corresponding ones in the other.

He showed also that all the principal phenomena of electricity were developed during the auroral display of 1859; that light was developed in passing from one conductor to another, that heat in poor conductors, that the peculiar electric shock to the animal system, the excitement of magnetism in irons, the deflection of the magnetic needle, the decomposition of chemical solutions, each and all were produced

during the Auroral storm, and evidently by its agency. There were also in America effects upon the telegraph that were entirely consistent with the assumption previously made by Walker for England, that currents of electricity moved from northeast to southwest across the country. From the observations of the motion of auroral beams, he showed that they also moved from north-northeast to south-southwest, there being thus a general correspondence in motion between the electrical currents and the motion of the beams.

When there is a special magnetic disturbance at any place, there is usually a similar one at all other neighboring places. But these disturbances do not occur at the several places at the same instant of time. Professor Loomis showed that in the United States they take place in succession as we go from northeast to southwest, the velocity of the wave of disturbance being over one hundred miles per minute. The waves of magnetic irregularities were thus connected with the electrical current and with the drifting motions of the streamers in the auroral display.

As incident to this discussion, he collected all available observations of auroras, and he deduced from them the annual number of auroras visible at each place of observation. These numbers, when written upon a chart of the Northern Hemisphere, showed that auroras were by no means equally distributed over the earth's surface. It was found that the region in which they occurred most frequently was a belt or zone of moderate breadth and of oval form, enclosing the North Pole of the earth, and also the North Magnetic Pole. It was therefore much farther south in the Western hemisphere than in the Eastern. Along the central line of this belt there are more than eighty auroras annually, but on going either north or south from the central line of that belt the number diminishes.

In 1870 Professor Loomis published a paper of importance relating to terrestrial magnetism, in which he showed its connection and that of the aurora with spots on the sun. That the spots on the sun had periods of maxima and minima development had long been known. Lamont had noticed a periodicity in the magnetic diurnal variations. Sabine and Wolf and Gauthier had noticed that the two peri-

odicies were allied. The connection of the period of solar spots with conjunction and opposition of certain planets had been shown by De La Rue and Stewart. Professor Loomis undertook an exhaustive examination of the facts that tended to confirm or refute the propositions that had been advanced. He confirmed and added to the conclusions of Messrs. De La Rue and Stewart. He also brought together such facts as were relevant to the question, and he showed that the regular diurnal variations of the magnetic needle were entirely independent of the solar spots, but that those disturbances that were excessive in amount were almost exactly proportional to the spotted surface of the sun. He also showed that great disturbances of the earth's magnetism are accompanied by unusual disturbances on the sun's surface on the very day of the storm.

Various forms of periodicity in the aurora have frequently been suggested. Professor Loomis, from all available accounts of the aurora, was able to show that while in the center of the zone of greatest auroral frequency auroras might be visible nearly every night, and hence that periodicity could not easily be shown by means of numbers of auroras recorded in such places, yet that such periodicity was distinctly traceable at places where the average number seen was about twenty or twenty-five a year. The times of maxima and minima of the solar spots were seen to correspond in a remarkable manner with the maxima and minima in the frequency of auroral displays in these middle latitudes. Also from the daily observations made by Messrs. Herrick and Bradley at New Haven during seventeen years, he concluded that auroral displays in the middle latitudes of America are generally accompanied by an unusual disturbance of the sun's surface on the very day of the aurora. The magnetism of the earth, the Aurora Borealis, and the spots on the sun, have thus all three a causal connection, and apparently that connection is closely related to the conjunctions and oppositions of certain planets.

Shortly after the publication of this memoir, Professor Lovering published his extensive catalogue of auroras. A further discussion of the periodicity of the auroras was undertaken by Professor Loomis and published in 1873. In this he made use of all the auroras recorded in Professor

Lovering's catalogue. They confirmed his previous conclusions, only slight modifications being required by the new facts presented, and by their more systematic collation.

In these papers, as in most of his papers upon other subjects, Professor Loomis was ever intent upon answering the questions: What are the laws of nature? What do the phenomena teach us? To establish laws which had been already formulated by others, but which still needed confirmation, was to him equally important with the formulation and proof of laws entirely new.

Let us now turn to another important line of Professor Loomis' work,—*Astronomy*. As I have said, he was early interested in the shooting stars. In October, 1834, he read a paper before the Connecticut Academy of Arts and Sciences upon this subject, probably in substance that which was shortly afterward published in this Journal.* The published paper is principally a restatement of the observations made in Germany in 1823 by Brandes in concert with his pupils for determining the path of the stars through the atmosphere, together with methods of computation. From the results of Brandes' observations, however, he deduces an argument for the cosmic character of the shooting stars. One month after reading this paper to the Connecticut Academy he engaged in similar concerted observations with Professor Twining, who was then residing near West Point, N. Y. These were only moderately successful, but they were the first observations of the kind undertaken in America.

During the senior year of his college course there arrived at New Haven the five-inch telescope, given to the college by Mr. Sheldon Clark, constructed by Dolland. This instrument was much larger than any telescope then in the country. It was temporarily placed in the Athenæum tower, where it was mounted on castors and wheeled to the windows for use. This temporary abode it occupied, however, for over thirty years. In spite of its miserable location it was, in the decade following its installment, a power in the development of the study of Astronomy in the college. The lives and works of Barnard, and Loomis, and Mason, and Herrick, and Lyman, and Chauvenet, and Hubbard, and of other graduates of the college prove this. What rich returns for Mr. Sheldon Clark's twelve-hundred-dollar investment!

* American Journal of Science and Arts.

In 1835 the return of Halley's comet had been predicted, and its appearance was eagerly expected by astronomers and the public: Professor Olmstead and Tutor Loomis first in this country caught sight of the stranger, and throughout its course they noted its physical appearances. With such means as he had at command Mr. Loomis observed the body's place, and computed from his observations the orbit.

The latitude and longitude of an Observatory are constants to be early determined. These were measured by President Day for Yale College in 1811. In the summer of 1835 Tutor Loomis, with such instruments as the College possessed, a sextant and a small portable transit, made numerous observations of Polaris for latitude, and several moon culminations for longitude. From these he computed the latitude and longitude of the Athenæum tower. The longitude from Greenwich, though obtained from a small number of observations, differs less than two seconds of time from our best determinations to-day. While in Europe in 1836-37 Professor Loomis, as I have said, bought for Western Reserve College the instruments for an Observatory. These were a four-inch equatorial, a transit instrument, and an astronomical clock. On his return he erected, in 1837, a small Observatory at Hudson, and in September, 1838, began to use the instruments. He had no assistant, and by day had a full allotment of college work. Two hundred and sixty moon culminations and sixteen occultations observed for longitude, sixty-nine culminations of Polaris for latitude, along with observations on five comets, sufficiently extended for a computation of their orbits; these attested his activity outside of his required duties. Some years later, when the corresponding European observations were made public, he prepared an elaborate discussion of these longitude observations, and published it in *Gould's Astronomical Journal*. A sixth comet was observed by him at Hudson in 1850.

It may not seem a very large output of work in six years' time to have determined the location of the observatory, and to have observed five comets. But we must recollect that the telegraph had not then been invented, that the exact determination of the longitude of a single point in the Western country had a higher value then than it can have now, and that it could be obtained only by slow and tedious

methods. These were, moreover, days of small things in astronomy in this country. At Yale College we had a telescope but not an Observatory. At Williamstown an Observatory had been constructed, but it was used for instruction, not for original work. At Washington Lieutenant Gilliss, and at Dorchester Mr. Bond, were commissioned by the government in 1838 to observe moon culminations in correspondence with the observers in the Wilkes exploring expedition for determining their longitude. These two prospective sets of observations, both of them under government auspices and pay, were the only signs of systematic astronomical activity in the United States outside of Hudson, when in 1838 Professor Loomis began his observing there.

In his Inaugural Address he asks: "Where now is our American Observatory? Where throughout this rich and powerful nation do you find a single spot where astronomical observations are regularly and systematically made? There is no such spot." When he left Hudson in 1844 the situation was not largely changed. Mr. Bond had removed his instruments and work to Cambridge. The High School Observatory at Philadelphia had been erected and Messrs. Walker and Kendall were using its instruments. Professor Bartlett had built the Observatory at West Point, and had begun to observe there. Lieut. Gilliss, after years of excellent work in the little establishment on Capitol Hill, had just finished the present Naval Observatory building at Washington, Professor Mitchel had begun to build the Cincinnati Observatory, and the Georgetown Observatory building had been erected. Professor Loomis's work at Hudson should be measured by what others were doing at the time, rather than by the larger performance of to-day.

In the summer of 1844, the year in which Professor Loomis came to New York, a new method in astronomy had its first beginnings. The telegraph line had just been built between Baltimore and Washington, and Capt. Wilkes at Baltimore compared his chronometer by telegraph with one at Washington, and so determined the difference of longitude of the two places.

Professor Bache was now Superintendent of the Coast Survey, and he determined at once to use the new method for the purposes of the survey. To Mr. Sears C. Walker

was committed the direction of the work, but scarcely less important were the services of Professor Loomis, who for three campaigns had charge of the end of the lines in Jersey City and New York. Their first partially successful efforts were made in 1846, but the practical difficulties were overcome and entire success was obtained by them in 1847 and 1848. In these years the differences of longitude of Washington, Philadelphia, New York and Cambridge were thus determined with an accuracy far greater than any previous similar determination whatsoever.

The next summer, that of 1849, Professor Loomis assisted in a like work to connect Hudson, Ohio, with the eastern stations. His observations of moon culminations at Hudson were thus available equally with those made at Philadelphia, Washington, Dorchester and Cambridge for determining the absolute longitudes of Atlantic stations from Greenwich. It was not until 1852 that European astronomers began to use these telegraphic measuring longitudes.

In 1850 Professor Loomis published a volume on the *Recent Progress of Astronomy, especially in the United States*. A first and a second edition were soon exhausted, and in 1856 the volume was entirely rewritten and very much enlarged. Some of the topics in these volumes were the subjects of articles communicated from time to time to the public in this Journal, *Harper's Magazine*, and other periodicals. Another important contribution to astronomy appeared in 1856, that is, his *Introduction to Practical Astronomy*. Eminent astronomers in England and America have expressed in the highest terms their praise of this book. Though it is now thirty-five years since its first appearance, and many treatises on the same subject, some elaborate and some elementary, have since been published, yet for an introduction to practical work I believe that a student will find this volume better than any other for his uses at the beginning of his course.

The increase of our knowledge in Astronomy was, from first to last, an object of special interest to Professor Loomis. Before he left New York the income from his text-books enabled him to make to Yale College the generous offer of coming to New Haven and working in an Observatory at his own charges, provided a suitable Observatory should becon-

structed and equipped for him. Unfortunately, the college was not able, although it was greatly desirous of doing it, to avail itself of his generous offer. Near the same time he joined with public-spirited citizens of New York in an effort to establish an astronomical Observatory in or near that city, and for that purpose an act of incorporation was obtained from the New York State Legislature. After coming to New Haven, he always took the warmest interest in the plans of Mr. Winchester for the establishment of an Observatory in connection with Yale University. His counsel and assistance have been instrumental, more than the public could know, in producing and preserving whatever of value has been developed in that Observatory.

PHOTOGRAPHS OF THE SURFACE OF MARS.

WM. H. PICKERING.

FOR THE MESSENGER.

A box of photographs has recently been received from Mr. Wilson, and contains among other things a number of negatives of the planet Mars. Seven views were taken April 9, between 22^h 56^m and 23^h 41^m, Greenwich mean time. Seven more were taken April 10, between 23^h 20^m and 23^h 32^m. Thus the same face of the planet was presented in both cases. Distinct and identifiable spots and markings are well shown in all the pictures, but in those taken on the latter date a considerable accession is shown to the white spot surrounding the south pole. It has been known for years that the size of these polar spots varied gradually from time to time, apparently diminishing in the summer, and increasing in the winter of their respective hemispheres. But I believe that this is the first time that the precise date, and approximate extent of one of these accessions has been observed. The area affected stretches from the terminator, which at this time was in long. 70°, along parallel - 30° to longitude 110°, thence to longitude 145°, latitude - 45°; thence to the limb which was in latitude - 85° on the 120° meridian, and thence back to the point of starting. It may thus extend also over an unknown area on what was at that time the invisible hemisphere of the planet. The visible area included

is surprisingly large, amounting to about 2,500,000 square miles or somewhat less than the area of the United States. Being near the limb, however, it is not as conspicuous as might at first sight be supposed. On the morning of April 9, the area was faintly marked out as if pervaded by haze, or by small separated bodies, too small and far apart, or too faint to be recognized individually. But on April 10 the whole region was brilliant, fully equaling that surrounding the north pole. In the mean time a much smaller area on the limb which on the 9th was very bright had either vanished or joined the main mass, by moving eastwardly, as we should say, considering Mars as a globe.

The date of these events corresponds to the end of the winter season on the southern hemisphere of Mars, or what would be with us about the middle of February. The numerical data given above are founded on the extremely useful tables published by Mr. Marth in the *Monthly Notices*.

As to what these observations mean, might most naturally be explained by terrestrial analogies, but be that as it may, the facts are that these appearances are conspicuous upon each of the fourteen photographs, and so distinctly so, that no one who had once seen them would hesitate an instant in deciding on which day any particular plate was taken.

ON THE REVERSED CURVATURE OF THE SHADOW ON SATURN'S RINGS.

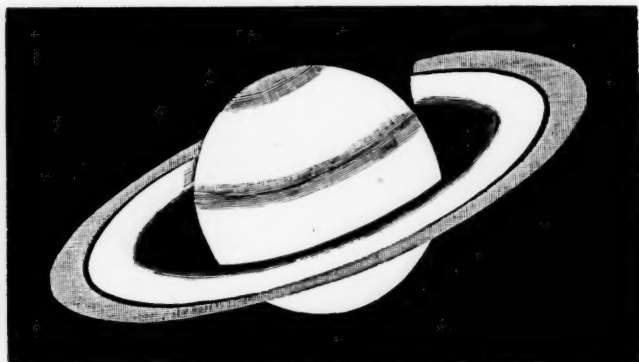
ALDRO JENKS.

FOR THE MESSENGER.

On the evening of April 25th, 1889, at about 8:30 P. M., I was examining Saturn with a power of about 180 on a $4\frac{1}{8}$ -inch achromatic by Brashear, when, much to my surprise, I found the shadow of the globe on the rings curved the wrong way, *i. e.* from the globe, as shown in the following drawing, "Fig. I."

Thinking my eyes might be deceiving me I called my wife, and without telling her what I had seen, requested her to describe the shape of the shadow. She described the shadow as having its right hand edge curved away from the planet.

I wrote to Professor Comstock of the Washburn Observatory about it, and was informed by him that while my observation of Saturn was unusual, it was far from being unprecedented; that the same appearance was observed in 1875 with the 26-inch achromatic at Washington, and that Webb, in "Celestial Objects for Common Telescopes," says: "The outline of this shadow has often been found curved the wrong way for its perspective." Professor Comstock also adds, "I do not know that any satisfactory explanation for this anomaly has ever been given."



In seeking the cause of this phenomenon the first explanation which presents itself is, that it is due to some personal idiosyncrasy, or peculiarity of vision of the observer; but when several observers see the same appearance, and this without previous intimation of what they are expected to see, it would seem to exclude that source of error.

As several eye-pieces were used it could not arise from distortion produced by the eye-piece. The objective is an excellent one, and has never shown any distortion of an object; besides, the same appearance has been seen through telescopes of the highest excellence.

It might be thought to be due to atmospheric causes, but it is not to be supposed that on every occasion when this appearance has been observed, the shadow *only* would be distorted by atmospheric causes.

Excluding these sources of error, we are forced to the con-

clusion that the cause of this phenomenon must be sought in some physical peculiarity of the ring system itself.

Long ago, Secchi pointed out that a reversed curvature of the shadow would result from a slight convexity in the ring. This is easily verified. With a lamp, globe and paper rings a little experiment will satisfy anyone that when the portion of the ring on which the shadow falls is made convex, a reversed curvature of the shadow always ensues, placing the eye and lamp in the same position relatively to the globe and ring that the earth and sun occupy to Saturn; and we also find, there is no other shape which can be given to the ring that will produce this effect.

We seem justified, then, in assuming that this appearance is produced by such a shape of the rings. This, however, is not satisfactory. The real question arises, what is the explanation of that explanation? It is evident the surface of the ring cannot be permanently convex, because, in that event, the shadow would always be found curved the wrong way; nor can any portion of the ring be permanently convex, or we should have this appearance at every revolution of the ring, and as the ring revolves in a little over ten and one half hours, it could be seen at some time on every clear night.

It is now known that Saturn's rings consist of countless independent meteors, moving each in its own orbit about the planet. The so-called crape ring consists of just such meteors, but their number is not great enough to arrest *all* the light and reflect it back to the eye of the observer, as in the two outer ones.

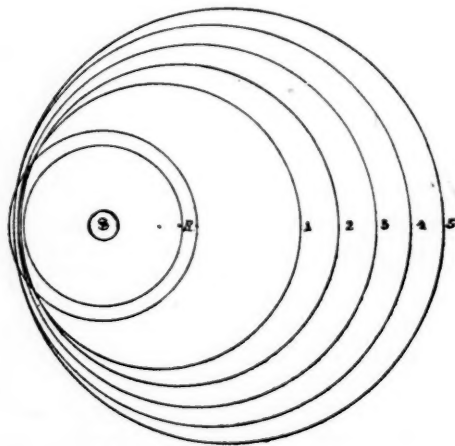
We then have this case, that, when the meteors are crowded together sufficiently they reflect the light so as to present the appearance of a solid, continuous body; but, when they are less numerous, as in the crape ring, they reflect less and still less light as their numbers decrease, up to the point of invisibility.

We know that there are in the solar system myriads of meteors aggregated into shoals, each separate shoal pursuing its course in its own orbit around the sun, being held there by the universal law of gravitation. The attractive power of gravitation, however, does not reside in the sun alone, but, it is conceivable that shoals of meteors might

revolve about a planet, and be held in their orbits by the attraction of its mass.

Now let us suppose there are revolving around Saturn in about the same plane as its rings, but independently of them, several shoals of meteors having one common point of their orbits immediately over the center of the rings, but spreading out to about the same width as the rings and being more numerous at the center than at either edge, and also having various periods of revolution in their orbits.

Such a system as is supposed would be represented in figure two; in which *S* would represent Saturn, *R* the rings, and 1, 2, 3, 4, and 5 the orbits of several shoals of meteorites.



When these several shoals of meteors were at this common point of their orbits at the same time, they would be so crowded together as to reflect the light from immediately over the center of the rings, and from a higher plane, but growing thinner towards each edge more and still more of the light would be reflected from a lower level, passing from the center towards each edge, and thus produce the appearance of a convex surface; and, if that point happened to fall under the shadow at such a time, a reversed curvature of the shadow would be the result.

Moving with different degrees of velocity in their several orbits they would soon be scattered out so as no longer to reflect the light in appreciable quantities, and the rings would again present their normal appearance.

No matter what the orbits or velocity of these shoals of meteors might be, they must all at regularly recurring intervals return to this common point. For illustration, suppose there are five such shoals, revolving in their respective orbits in periods of 1, 2, 3, 4, and 5 days; at the end of sixty days they would all be in conjunction again at this common point. If this point did not also at that time fall under the shadow it would not be perceptible to us (except at those rare intervals when the edge of the ring is turned towards us, when it would be seen as a bead of light), another sixty days must then ensue, and so on, until some conjunction would be found to fall under the shadow. But as the shadow covers only a small portion of the rings it is evident that this condition could be observed only at rare and irregular intervals.

If only a portion of the shoals were in conjunction, say those whose orbits lay more immediately over ring *B*, then the shadow might present a notched appearance as has been observed by Schroeder, La Place, De la Rue and Jacob.

Only two objections to this hypothesis present themselves to my mind, neither of which, it seems to me, is fatal to the theory. The first is that it would require two sets of shoals, one on each side of the ring, as the shadow has been found thus curved on both sides of the rings. When seen at Washington in 1875 the shadow must have been on the north side, and when seen by me it was on the south side of the rings. According to the nebular hypothesis, this ring system must have been formed by the contraction of nebulous matter from a more widely diffused state, and the lateral attraction would be towards the center, instead of towards the extreme side of the mass. This would probably result in leaving outlying portions of meteoric matter on each side of the rings.

The other objection that might be urged is, that the attraction of the rings would swerve these meteoric shoals from their paths, and cause them to be absorbed into, and become a part of the rings. But this objection would be just

as fatal to the theory that the rings are composed of meteorites, as it would to the hypothesis I have proposed. Granting the force of the objection, the process still might be an extremely slow one, like the earth gathering up the meteorites during the November showers. It would simply follow that it is only an existing phase of the ring system we observe, but that "existing phase" might extend over many thousands of years.

Besides the facts above mentioned, this hypothesis derives some support from the fact that the divisions in the rings have, at times, been observed to be partially obliterated; and from the further fact that there is a small percentage of outstanding perturbations of the inner satellites unaccounted for.

Accepting this hypothesis, we could account for these anomalous appearances in a manner justified by experiment, also for their appearance at rare and irregular intervals and only at such intervals, for the notched appearance the shadow sometimes presents, for the beads of light sometimes seen in connection with the rings when the edge is turned towards us, and for their non-appearance at other times under similar circumstances; in short, it seems to me, that this hypothesis is competent to account in a rational manner for all the observed phenomena, while the observed facts certainly call for some explanation.

It also seems reasonable to suppose that shoals of meteors should abound in connection with meteoric rings.

Why then should we not accept this hypothesis until some more probable explanation is proposed to account for the facts?

DODGEVILLE, Wis., Dec. 4th. 1889.

CELESTIAL PHENOMENA EXPLICABLE BY METEORS.*

W. H. S. MONCK.

Although I am of the opinion that we have no conclusive evidence of the existence of meteors outside the limits of the solar system, I think it will be conceded that their existence

* A paper read before the Royal Dublin Society in January, 1886.

is highly probable; and this probability may be raised to something approaching certainty if we are able to explain by their means phenomena of which no other satisfactory explanation has been given. The first phenomenon, however, with which I propose to deal lies within the solar system, where we know as a fact that meteors abound, and the only question is as to the sufficiency of the proposed explanation. I allude to the shortening of the major axis of the orbit of Encke's comet, which is usually ascribed to the presence of a resisting medium. Now it seems to me that without supposing that the ether offers any resistance to motion, or that there is a solar atmosphere of great tenuity extending as far as the orbit of the Encke's comet, this resistance may be accounted for by the flights of meteors which the comet must encounter in the course of its revolution. It is true that some of the meteors probably overtake the comet and thus tend to accelerate its motion, but the comet probably overtakes an equal number, and is thus retarded to the same extent. So much for the cases where the comet and the meteors are both moving towards or from their respective perihelia, but the majority of the collisions occur when they are moving in opposite directions,—the comet approaching the sun and meteors receding from it, or *vice versa*. Moreover, the retardation is in this case proportional to the sum of the velocities of the comet and of the flight of meteors, while if the same flight overtook the comet the acceleration would be proportional to the difference of the velocities, which would usually be very small. The total effect of the collisions between the comet and the meteors must, therefore, be to retard the motion of the comet. It has been computed that 7,500,000 meteors, on an average, enter our atmosphere every day. I should be disposed to make a lower estimate, but a much lower one would be sufficient for my purpose. These meteors produce no perceptible effect on the earth's motion, but the result might be very different if the earth, while occupying the same space as before, was reduced to one-millionth part of its weight. This would assimilate it more nearly to the condition of the comet; and meteors are probably more densely packed in space as we approach the sun. I have not made any mathematical computations on the subject but I think when they

are made it will be found that the observed retardation of Encke's comet may be accounted for by collision with meteors without increasing the number and velocity of these meteors to an incredible extent.

Some time ago, in a paper read before this Society, I noticed the great decline of light among the fainter stars, and suggested as an explanation that the ether absorbs light. I was not aware at the time that a somewhat similar theory had been previously put forward by the great astronomer Struve. But it has since occurred to me that this decline of light in the case of remote stars may be due to the interposition of flights of meteors. To show the credibility of this explanation I desire to call attention to the great extent of surface which a body of moderate dimensions may be made to exhibit by breaking it up into small fragments. To take the simple case of spheres, the solid contents of a sphere is proportional to the cube of the radius, while the surface is proportional to the square of the radius, and therefore if we could parcel out a large sphere completely into small spheres, the total extent of surface would be enormously augmented. Suppose the radius of each small sphere to be $\frac{1}{n}$ th of that of the large one the number of these spheres would be n^3 and the surface of each would be $\frac{1}{n^2}$ of that of the large sphere, so that if the small spheres were so arranged that none would be placed behind another the total surface would be n times as great as before. It would, indeed, probably be still greater because the interior portions of the large sphere would be in a state of great compression while those of the smaller spheres would not. It is very probable that the average size of a meteor does not exceed that of a sphere with a diameter of three inches. If the moon was cut up into such spheres its surface would be multiplied by forty-five millions, and if the spheres were not placed behind each other they would cover a portion of the sky nearly equal to that now occupied by the moon, when removed to the distance of Uranus. They would probably occupy a still larger portion of the sky if scattered up and down between the sun and the orbit of Neptune. But if the number of meteors which the earth encounters every day is to be reckoned by millions or even by hundreds of thousands, I think it is not unreasonable to suppose that the entire number of them

comprised within the orbit of Neptune would form a body as large as the moon, in which case the quantity of light intercepted by them could not be regarded as inappreciable. Now supposing that meteors in anything like the same numbers are to be found in the remoter regions of space, the diminution of light owing to their presence must be considerable. They would probably be most thickly packed in the regions where the fixed stars are most numerous and their influence in diminishing the light of the fainter stars would be most observable in these directions. If, moreover, there is the same connection between meteors and nebulae that is known to exist between meteors and comets, we may expect to find them densely crowded in the neighborhood of true or gaseous nebulae, producing in such cases a very considerable diminution of light. At all events I think the observed declension in the light of the fainter stars may be accounted for by the interposition of meteors without assigning either an incredible density to these meteors or an incredible distance to the stars whose light they intercept.

I now pass to a class of variable stars together with the stars known as new stars. Some variable stars like Algol probably belong to a different class, but the characteristics of the class to which I refer and which I may call irregular variables are sufficiently startling. They often attain a very considerable degree of brilliancy and then fade away rapidly. The known laws of cooling seem to exclude the supposition that large bodies could change their temperature so rapidly, and, moreover, even when the star is brightest, the spectrum does not seem to indicate that the temperature is abnormally high. Are they then small bodies? Apparently not; for if so, they must be near us; whereas none of them, I believe, has as yet been found to exhibit a sensible parallax. The difficulty, I think, disappears if we suppose a new star to consist of a number of small bodies so near together that our telescopes cannot separate them. Saturn's rings are now generally believed to consist of numbers of small bodies of this description: and supposing that one of our great meteor showers could be seen from α Centauri by a telescope much more powerful than Lord Rosse's, it is almost certain that it would be taken for a single luminous object. A dense cloud of meteors heated to luminosity

might be visible to a great distance, but as each individual meteor would be very small, cooling would follow rapidly when the source of heat was withdrawn. Again if the meteors were exposed a second time to the source of heat, their luminosity would augment as rapidly as it had previously diminished. Some of the new or irregularly variable stars to which I refer have, moreover, appeared to present planetary discs rather than to resemble ordinary fixed stars. This gives us the idea of much enlarged dimensions—of a cloud of meteors with a diameter of several millions of miles, rather than a single body with a diameter much less than that of the sun.

I think we can go further and assign a probable cause for the luminosity of these meteors. We know that those which we experience are not luminous until they enter the atmosphere, but are raised to luminosity by rushing through it. A similar effect would be produced by a body of meteors rushing through any other gaseous mass. But we have undoubtedly in space masses of gas whose dimensions exceed that of our atmosphere perhaps as much as the sun exceeds one of our atmospheric meteors. A cloud of meteors rushing through such a mass of gas would be visible to a great distance. It would probably either be partly vaporised or would heat the gas through which it was rushing to such a degree as to produce more or less of a gaseous spectrum in connection with the continuous spectrum of the heated meteors. But it has been remarked that these irregularly variable stars and new stars almost always appear in connection with a nebula, and when at their greatest intensity there is usually a trace of a gaseous spectrum along with the continuous spectrum of the star. Mr. Proctor has moreover observed that they almost always occur close to, or in, the Milky Way, and therefore just in the places where we might expect to find the largest number of meteors.

I am aware that the great Andromeda nebula in which the last of these new stars has appeared, is not supposed to be gaseous, inasmuch as its spectrum is continuous, though apparently shortened at the red extremity. This fact, however, is not conclusive as to the absence of a large mass of gas in the locality in question. The deficiency at the red extremity is moreover greater in the case of the nebula than of

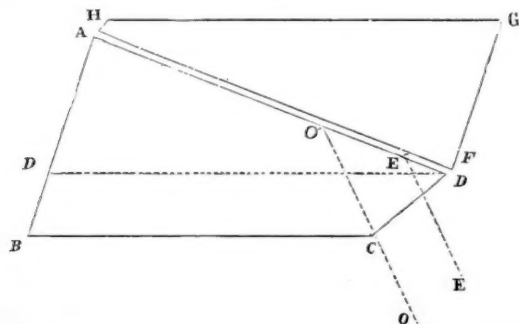
any known star, and in this respect the spectrum resembles that of the nucleus of the comet known as Coggia's, which was probably in a partly gaseous condition. The deficiency at the red end may be due to the intervention of an absorptive gas, or possibly to the intervention of a cloud of meteors if it should prove that red light loses more in bending round a small object than light of higher refrangibility. At all events, flights of meteors rushing through a gaseous medium seem to me to explain more of the facts than any other theory hitherto proposed, and if we have independent reasons for believing in the existence of these flights of meteors this explanation attains a high degree of probability.

In conclusion, I may make a remark as to the theory which would ascribe the solar heat, or at all events its maintenance, to collision with meteors. As far as our experience reaches, the orbits of meteors are not such as would lead them to fall into the sun. They appear to be of a cometary character, and no comet has as yet been known to fall into the sun. Nearer to the sun, indeed, meteors may be moving in orbits of a different character; but where do these meteors come from? If they do not come from inter-stellar space or from the outer portions of the solar system (in either of which cases we might expect to meet with some of them while travelling towards the sun), we can hardly account for their existence otherwise than by ejection from the sun himself: and it seems pretty obvious that the sun could not acquire heat by ejecting particles from his surface and then catching them again in their descent. The ejection and recapture may very possibly occur; but if so, the heat given back by the recapture has evidently been derived from the sun himself and represents heat given out otherwise than by the ordinary process of radiation. The problem how the sun can give out such a quantity of heat by radiation and still retain his temperature therefore remains unsolved, unless there is some special reason why the meteors from outer space which are destined to fall into the sun should avoid the earth when approaching their destination. But I doubt if any such special reason can be assigned. As regards the earth, I may notice that no marked rise of temperature has been observed even after the densest meteor shower. Why should it be otherwise with the sun?

POLARIZED REFLECTIONS IN A NICOL'S PRISM.

E. J. SPITTA.

In a paper read before the R. A. S. on Friday, March 14, attention was called to the peculiar effect of using a polarizing apparatus to evaluate a Pritchard's wedge without the employment of a diaphragm placed between the Nicol and the eye. It was not within the scope of that paper to speak of what I submit may be an explanation of the cause *why* the internal reflections in the prism demand its being turned through a greater or less angle according to the position of the zero, than is found to be necessary when a diaphragm is employed, so perhaps the following remarks may be worthy of notice by those who are interested in the subject. To explain the matter clearly, a diagram and brief explanation of one of the Nicols I had specially cut to show the rays immediately before their last reflection must be given.



It will be noticed first that this nicol differs from an ordinary one in being much wider from H to B and G to C than is usual, an imaginary line drawn from F or D parallel to BC to meet the line AB at D' being the usual limit of the spar. The diagram speaks for itself and shows the prism separated, but ready to be united with Canada balsam. If now the portion ABCD be firmly fixed, say, in a Bunsen's holder, and a slit be placed before AB between the spar and a candle protected by a monochromatic piece of glass, whilst the eye is placed at CD, several images will be seen; but the most prominent are those formed by the extraordinary ray seen in the direction EE' and that due to the ordinary ray

OO', both of which are evidently due to reflections from the surface AD. But if these images be looked at attentively, and especially if the prism be itself slightly moved, they will be found to be double, the fainter image in each case being polarized in the opposite plane to that which is the more intense. Hence four images are really to be seen—a strong one extraordinarily polarized, side by side with a feeble one ordinarily polarized, and at some distance a strong ordinary, side by side with a feeble extraordinary. But this is not all. Owing to the angle which the prime extraordinary ray makes with the surface AD, being so close to, if not actually less than, the critical angle for that ray, total reflection takes place until the optical continuity of the spar, so far as it relates to this ray, is completed by the Canada balsam with the piece HFG. If now this second piece HFG be affixed with balsam whilst the eye watches the strong ray EE' through the surface CD, it will be seen that it does not entirely pass through the balsam as many authorities aver, but, on the contrary is only partially transmitted, for the image still reflected after union is made with the piece HFG is by no means a feeble one. If, now, a tourmaline is so placed over the face CD as to exclude *both* extraordinary rays the images formed by the two ordinary ones will alone be visible, and it will then be found that the plane of the faint ordinary, which was side by side with the strong extraordinary image, is *slightly turned on its axis*. In other words, if a second Nicol be employed and placed between the eye and the tourmaline, the two images will not become evanescent at the same angle of rotation of the Nicol; and if the tourmaline be now moved so as to hide both *ordinary* images and leave the two extraordinary ones, they also will be found *not to disappear at the same moment*, but sensibly one after the other. Lastly, and most important, if the plane of the extraordinary image as seen at the surface GD be compared with that of EE' and that of OO', it will be found the planes of the first and last are very nearly if not quite coincident, but that the plane of polarization for *both* rays at EE' is *sensibly rotated*. How it arises that the plane of one set of reflections is more rotated than that of the other, I must leave to those more versed in optical mathematics; but the fact is patent enough with any reasonable

inspection of the Nicol in question. Inasmuch then as these rays are among those cut off by the diaphragm it is proposed to use, for in an ordinary Nicol they would be again reflected off the surface DD', it is, I submit, open to consideration whether their presence, if unchecked, would not be sufficiently potent to cause the prism to be under-rotated or over-rotated, according to which side of the zero the observation was made. The result of such an over and under turning would be that the angle enclosed between the two points of equalization would be falsely reduced and the ratio obtained correspondingly too high. But as the computed ratio of light practically depends on $\cot^2 \frac{1}{2}(q' - q)$, an error in the determination of this angle would introduce an alteration in the ratio of the lights of

$$-2 \cot \frac{1}{2}(q' - q) \operatorname{cosec}^2 \frac{1}{2}(q' - q) \Delta \frac{1}{2}(q' - q).$$

This is only another way of saying that, with intensities which vary but little, half a degree (neglecting squares and products) would alter the ratio from 2.13 to 2.05, where one, for example, is but twice as bright as the other; but in the case of the ratio dealt with being higher, such, for example, as 1 to 18, the alteration produced by half a degree would amount to 1.133. Consequently, the amount of error produced in the coefficient of a wedge would vary with its depth and with its density, provided the same distance between the slits was rigidly maintained.—*The Observatory*, No. 162.

EQUATION OF THE ELLIPSE THROUGH FIVE GIVEN POINTS.

CHAS. E. MYERS.

FOR THE MESSENGER.

If we divide the equation $Ay^2 + Bxy + Cx^2 + Dy + Ex + F = 0$ by F , denoting the new coefficients by subscripts, we have $A_1y^2 + B_1xy + C_1x^2 + D_1y + E_1x + 1 = 0$. Substituting in this the co-ordinates of the five points, we get:

$$A_1y_1^2 + B_1x_1y_1 + C_1x_1^2 + D_1y_1 + E_1x_1 + 1 = 0$$

$$A_1y_2^2 + B_1x_2y_2 + C_1x_2^2 + D_1y_2 + E_1x_2 + 1 = 0$$

$$A_1y_3^2 + B_1x_3y_3 + C_1x_3^2 + D_1y_3 + E_1x_3 + 1 = 0$$

$$A_1y_4^2 + B_1x_4y_4 + C_1x_4^2 + D_1y_4 + E_1x_4 + 1 = 0$$

$$A_1y_5^2 + B_1x_5y_5 + C_1x_5^2 + D_1y_5 + E_1x_5 + 1 = 0$$

The values of A_1 , B_1 , C_1 , D_1 , and E_1 determined from these five equations, and substituted in the equation $A_1y^2 + B_1xy + C_1x^2 + D_1y + E_1x + 1 = 0$, gives an equation of a conic section passing through five points, $x_1y_1 : x_2y_2$ etc.

When $B^2 - 4AC < 0$ the section is an Ellipse,

When $B^2 - 4AC > 0$ the section is an Hyperbola,

When $B^2 - 4AC = 0$ the section is a Parabola,

When $B^2 - 4AC = 4(e^2 - 1)$, and $e =$ eccentricity of the curve.

TABLES FOR THE DETERMINATION OF THE MERIDIAN OF ELONGATION OF POLARIS.*

L. ENAS GIFFORD WELD.†

The following tables have been computed for the use of land surveyors and engineers during the current year (1890). In Table I. the times of elongation are given to the nearest ten seconds, and the azimuths to the nearest five seconds of arc.

TABLE I.

Azimuths at Elongations and Local Mean Times of Elongations of Polaris for 1890, Latitude $41^{\circ}40'$ N., and Latitude 6^h west of Greenwich.

Civil Date	Azimuth ° ' ''	Eastern Elongation		Western Elongation	
		h. m. s.		h. m. s.	
January 1	1 42 20	12 37 40	P. M.	12 30 40	A. M.
February 1	1 42 20	10 35 20	A. M.	10 24 10	P. M.
March 1	1 42 30	8 44 50	"	8 33 50	"
April 1	1 42 40	6 42 40	"	6 31 40	"
May 1	1 42 55	4 44 50	"	4 33 50	"
June 1	1 43 5	2 43 20	"	2 32 20	"
July 1	1 43 5	12 45 50	"	12 34 50	"
August 1	1 43 0	10 41 30	P. M.	10 33 20	A. M.
September 1	1 42 50	8 39 0	"	8 31 50	"
October 1	1 42 35	6 41 20	"	6 34 10	"
November 1	1 42 20	4 39 20	"	4 32 20	"
December 1	1 42 5	2 41 10	"	2 34 10	"
January 1, 1891.....	1 41 55	12 38 50	"	12 31 50	"

The local mean times of elongation should be increased 9.8^s for each hour of longitude *east* of the meridian of the table, and diminished by the same amount for each hour *west*.

* From *The Transit*, Vol. II., No. 1, a semi-annual publication of the Engineering Society of the State University of Iowa.

† Professor of Mathematics and Astronomy, University of Iowa.

If standard time be employed it should be reduced to local mean time.

By means of the auxiliary tables given below, the above table may be used through a range of ten degrees of latitude.

TABLE II.

For other latitudes within 5° of $41^{\circ} 40'$ N., the following corrections are to be added (algebraically) to the azimuths of Polaris given in Table I.

North	Difference in Latitude	South
	°.	
1 39	1	— 1 35
3 24	2	— 3 4
5 13	3	— 4 29
7 7	4	— 5 49
9 6	5	— 7 4

TABLE III.

For other latitudes within 5° of $41^{\circ} 40'$ N. the following corrections are to be added (algebraically) to the times of eastern elongation, and subtracted (algebraically) from the times of Western elongation given in Table I.

North	Difference in Latitude	South
	°.	s
10	1	— 9
20	2	— 19
31	3	— 28
41	4	— 37
52	5	— 45

CURRENT CELESTIAL PHENOMENA.

THE PLANETS.

Mercury, having just passed inferior conjunction, will not be in good position for observation until the latter part of June, when it will rise about an hour earlier than the sun. It will be at greatest elongation west from the sun, $22^{\circ} 20'$, June 23; in perihelion July 15; at superior conjunction with the sun July 22; in conjunction with Saturn, south $34'$, August 9, at 11 P. M. Mercury will be in good position for daylight observations of the gibbous phase during the first half of July and the same part of August.

During the first days of May this planet was quite conspicuous to the naked eye in the evening and we had several excellent views of it with the telescope both during the day and at night. Only once were we able to make out any sign of a dusky marking upon the disk, and that was very indistinct.

Venus must be recognized by any one who looks toward the west in the evening, her brilliancy far exceeding that of any other object in western sky, except the moon, and being sufficient to cause perceptible shadows of objects upon the earth. She is easily visible to the unaided eye at noon, if the air is clear and the observer knows just where to look. With the 8-inch telescope we have not as yet been able to discover any trace of dark markings upon the surface of the planet. *L'Astronomie* (May, 1890, p. 192), has however, received from Professor Schiaparelli some important researches tending to verify the adopted value of the rotation period of Venus. These researches will be published in *L'Astronomie*. We shall look for them with interest.

Mars is now at his least distance from the earth, for this opposition, 45,000,000 miles. This planet is very conspicuous in the southeast at 10 p. m. in the constellation of *Scorpio*. *Mars* will move westward through the constellation until July 4, after which it will move eastward, coming to conjunction with *Antares* August 13. The diameter of *Mars*, June 1, is 20.8", July 1, 19.0", August 1, 15"; the phase June 1, 0.997, July 1, 0.945, August 1, 0.883. It is unfortunate for observers in the northern hemisphere that when *Mars* is nearest his declination is lowest, so that he is seen under unfavorable circumstances. It is to be hoped that astronomers in the southern hemisphere, where *Mars* approaches the zenith, will pay much attention to the study of his surface, during this opposition and the one in 1892.

Jupiter also will be best seen in the southern hemisphere. He will describe a short retrograde path in *Capricorn* where there are no bright stars. He may in our latitude be found in the southeast after midnight in June, after 10 p. m. in July, and after 8 p. m. in August. The polar diameter of *Jupiter's* disk will be 41.4" June 1, 44.8" July 1, and 46.2" August 1. He will be at opposition July 30. Transits of the shadow of satellite IV will be comparatively frequent during this summer and micrometrical measurements of the position of this shadow upon *Jupiter's* disc, with the exact time of the measurements, will be of value for determining the elements of the satellite's orbit.

Saturn may be seen toward the southwest in the early evening in the constellation *Leo*, near the bright star *Regulus*, and will move slowly eastward in that constellation. The sun is gaining rapidly upon him, however, so that in August *Saturn* will be lost to sight. On July 17, at 10^h 36^m A. M., *Saturn* and *Venus* will be in conjunction, *Venus* being only 6' south of *Saturn*.

Uranus will be at quadrature, 90° east from the sun, July 14. He may be found on the meridian at about 8:30 p. m., a little northeast of the star *Spica* in *Virgo*, between the fifth magnitude stars *h* and *S* *Virginis*, and is moving very slowly.

Neptune is on the other side of the sun and so will not be visible this summer.

MERCURY.

1890.	R. A. h m	Decl. °	Rises. h m	Transits. h m	Sets. h m
June 25.....	4 43.4	+19 11	3 05 A.M.	10 28.5 A.M.	5 52 P.M.
July 5.....	5 40.8	+22 16	3 08 "	10 46.3 "	6 25 "
15.....	7 04.0	+23 27	3 45 "	11 30.1 "	7 15 "
25.....	8 34.9	+20 30	4 52 "	12 21.4 P.M.	7 51 "
Aug. 5.....	9 59.9	+13 46	6 03 "	1 02.7 "	8 02 "
15.....	11 01.4	+ 5 56	6 59 "	1 26.3 "	7 53 "

VENUS.

1890.	R. A. h m	Decl. °	Rises. h m	Transits. h m	Sets. h m
June 25.....	8 36.0	+20 29	6 51 A.M.	2 20.4 P.M.	9 50 P.M.
July 5.....	9 24.2	+17 05	7 15 "	2 29.1 "	9 43 "
15.....	10 10.0	+12 57	7 40 "	2 35.4 "	9 31 "
25.....	10 53.7	+ 8 19	8 03 "	2 39.8 "	9 16 "
Aug. 5.....	11 39.8	+ 2 51	8 28 "	2 42.4 "	8 57 "
15.....	12 20.5	- 2 16	8 48 "	2 43.6 "	8 39 "

				MARS.		
1890.	R. A.	Decl.		Rises.	Transits.	Sets.
	h m	°		h m	h m	h m
June 25.....	15 42.1	-22 41		4 58 P.M.	9 25.2 P.M.	1 52 A.M.
July 5.....	15 39.9	-22 45		4 21 "	8 43.7 P.M.	1 06 "
15.....	15 43.5	-23 02		3 43 "	8 08.0 "	12 33 "
25.....	15 52.5	-23 31		3 19 "	7 37.6 "	11 56 P.M.
Aug. 5.....	16 07.6	-24 11		2 50 "	7 09.4 "	11 29 "
15.....	16 25.3	-24 50		2 32 "	6 47.8 "	11 04 "
				JUPITER.		
June 25.....	20 54.9	-18 06		9 48 P.M.	2 47.9 A.M.	7 26 A.M.
July 5.....	20 51.3	-18 23		9 07 "	1 54.2 "	6 42 "
15.....	20 46.7	-18 43		8 24 "	1 10.4 "	5 56 "
25.....	20 41.3	-19 04		7 42 "	12 26.0 "	5 10 "
Aug. 5.....	20 35.9	-19 27		6 55 "	11 36.9 P.M.	4 19 "
15.....	20 30.8	-19 46		6 11 "	10 52.6 "	3 34 "
				SATURN.		
June 25.....	10 09.9	+13 02		8 58 A.M.	3 54.0 P.M.	10 50 P.M.
July 5.....	10 13.4	+12 42		8 24 "	3 18.2 "	10 13 "
15.....	10 17.4	+12 19		7 50 "	2 42.8 "	9 36 "
25.....	10 21.6	+11 55		7 16 "	2 07.7 "	8 59 "
Aug. 5.....	10 26.6	+11 26		6 40 "	1 29.4 "	8 19 "
15.....	10 31.2	+10 59		6 07 "	12 54.8 "	7 42 "
				URANUS.		
June 25.....	13 24.5	- 8 15		1 37 P.M.	7 08.0 P.M.	12 39 A.M.
July 5.....	13 24.5	- 8 16		12 58 "	6 28.6 "	11 59 P.M.
15.....	13 24.8	- 8 18		12 19 "	5 49.7 "	11 20 "
25.....	12 25.5	- 8 22		11 41 A.M.	5 11.1 "	10 41 "
Aug. 5.....	13 26.5	- 8 29		10 59 "	4 28.9 "	9 59 "
15.....	13 27.7	- 8 37		10 22 "	3 50.8 "	9 20 "
				NEPTUNE.		
June 25.....	4 15.0	+19 39		2 35 A.M.	10 00.1 A.M.	5 25 P.M.
July 5.....	4 16.4	+19 43		1 56 "	9 22.1 "	4 48 "
15.....	4 17.6	+19 45		1 18 "	8 44.0 "	4 10 "
25.....	4 18.7	+19 48		12 39 "	8 05.1 "	3 32 "
Aug. 5.....	4 19.7	+19 50		11 57 P.M.	7 23.5 "	2 50 "
15.....	4 20.3	+19 51		11 18 "	6 44.9 "	2 12 "
				THE SUN.		
June 25.....	6 17.7	+23 23		4 17 A.M.	12 02.4 P.M.	7 48 P.M.
July 5.....	6 59.1	+22 45		4 22 "	12 04.3 "	7 46 "
15.....	7 39.9	+21 28		4 30 "	12 05.7 "	7 42 "
25.....	8 19.9	+19 34		4 40 "	12 06.3 "	7 33 "
Aug. 5.....	9 02.7	+16 52		4 52 "	12 05.7 "	7 20 "
15.....	9 40.6	+13 55		5 03 "	12 04.2 "	7 05 "
				THE MOON.		
June 20.....	8 42.9	+21 58		6 52 A.M.	2 46.9 P.M.	10 35 P.M.
25.....	12 42.5	+ 0 58		12 00 M.	6 26.1 "	12 40 A.M.
30.....	17 15.4	-22 40		6 00 P.M.	10 38.5 "	3 12 "
July 5.....	22 45.0	-13 23		10 34 "	3 47.7 A.M.	9 09 "
10.....	2 15.1	+ 9 22		12 17 A.M.	7 01.5 "	1 54 P.M.
15.....	6 37.9	+24 29		3 00 "	11 03.9 "	7 07 "
20.....	10 53.4	+12 32		7 47 "	2 59.1 P.M.	10 00 "
25.....	14 49.9	-12 54		1 09 P.M.	6 35.2 "	11 52 "
30.....	20 04.8	-23 24		7 00 "	11 29.6 "	2 01 A.M.
Aug. 5.....	1 57.1	+ 7 38		10 21 "	4 57.4 A.M.	11 42 "
10.....	5 26.3	+23 12		12 17 A.M.	8 10.3 "	4 08 P.M.
15.....	9 50.1	+17 50		4 38 "	12 13.7 P.M.	7 40 "

CERES (1)						
1890.	R. A. h m	Decl. °	Rises. h m	Transits. h m	Sets. h m	
June 4.....	15 28.8	-13 02	5 23 P.M.	10 34 P.M.	3 45 A.M.	
28.....	15 15.6	-14 02	3 41 "	8 48 "	1 55 P.M.	
JUNO (3)						
June 16.....	16 08.9	- 2 56	4 35 P.M.	10 27 P.M.	4 19 A.M.	
July 10.....	15 56.3	- 3 29	2 50 "	8 40 "	2 30 "	
Aug. 3.....	15 54.6	- 5 03	1 20 "	7 04 "	12 48 "	

[The above tables give local times for the Central Meridian and latitude +44° 28'.]

Phenomena of Jupiter's Satellites.

Central Time.						
d.	h. m.					
June 15...	10 21 P.M.	I.	Sh. In.			
11 14 "	"	II.	Ec. Dis.			
11 20 "	"	I.	Tr. In.			
16...12 41 A.M.	I.	Sh. Eg.				
1 09 "	III.	Sh. In.				
1 40 "	I.	Tr. Eg.				
10 36 P.M.	IV.	Oc. Re.				
10 54 "	I.	Oc. Re.				
17...10 43 "	II.	Tr. Eg.				
19...10 33 "	III.	Oc. Re.				
23...12 14 A.M.	I.	Sh. In.				
1 06 "	I.	Tr. In.				
1 48 "	II.	Ec. Dis.				
24...12 41 "	I.	Oc. Re.				
9 52 P.M.	I.	Tr. Eg.				
10 10 "	II.	Tr. In.				
11 17 "	IV.	Sh. Eg.				
11 26 "	II.	Sh. Eg.				
25... 1 05 A.M.	II.	Tr. Eg.				
2 07 "	IV.	Tr. In.				
27... 2 01 "	III.	Oc. Re.				
30... 2 08 "	I.	Sh. In.				
11 26 P.M.	I.	Ec. Dis.				
July 1... 2 26 A.M.	I.	Oc. Re.				
8 36 P.M.	I.	Sh. In.				
9 17 "	I.	Tr. In.				
10 56 "	I.	Sh. Eg.				
11 10 "	II.	Sh. In.				
11 37 "	I.	Tr. Eg.				
2...12 30 A.M.	II.	Tr. In.				
8 53 P.M.	I.	Oc. Re.				
3... 9 47 "	II.	Oc. Re.				
11 16 "	III.	Ec. Dis.				
8... 1 21 A.M.	I.	Ec. Dis.				
9...10 38 P.M.	I.	Oc. Re.				
11...12 02 A.M.	II.	Oc. Re.				
9 47 P.M.	IV.	Tr. Eg.				
14... 8 46 "	III.	Sh. Eg.				
10 21 "	III.	Tr. Eg.				
16...12 24 A.M.	I.	Sh. In.				
12 43 "	I.	Tr. In.				
17...12 22 "	I.	Oc. Re.				
9 13 P.M.	I.	Sh. Eg.				
Central Time.						
d.	h. m.					
July 17...	9 31 P.M.	I.	Tr. Eg.			
10 48 "	"	II.	Ec. Dis.			
19... 8 37 P.M.	II.	Sh. Eg.				
9 06 "	IV.	Ec. Dis.				
9 09 "	II.	Tr. Eg.				
21... 9 07 "	III.	Sh. In.				
9 57 "	III.	Tr. In.				
22...12 46 A.M.	III.	Sh. Eg.				
1 38 "	III.	Tr. Eg.				
11 39 P.M.	I.	Ec. Dis.				
24... 8 47 "	I.	Sh. In.				
8 54 "	I.	Tr. In.				
11 07 "	I.	Sh. Eg.				
11 14 "	I.	Tr. Eg.				
25... 1 23 A.M.	II.	Ec. Dis.				
8 32 P.M.	I.	Oc. Re.				
26... 8 30 "	II.	Tr. In.				
11 14 "	II.	Sh. Eg.				
11 25 "	II.	Tr. Eg.				
29... 1 07 A.M.	III.	Sh. In.				
1 13 "	III.	Tr. In.				
31... 1 30 "	I.	Oc. Dis.				
10 38 P.M.	I.	Tr. In.				
10 41 "	I.	Sh. In.				
Aug. 1...12 58 A.M.	I.	Tr. Eg.				
1 01 "	I.	Sh. Eg.				
7 56 P.M.	I.	Oc. Dis.				
10 18 "	I.	Ec. Re.				
2... 7 30 "	I.	Sh. Eg.				
10 46 "	II.	Tr. In.				
10 57 "	II.	Sh. In.				
4... 8 04 "	II.	Ec. Re.				
5... 7 47 "	IV.	Ec. Re.				
8...12 22 A.M.	I.	Tr. In.				
12 35 "	I.	Sh. In.				
9 40 P.M.	I.	Oc. Dis.				
10 46 "	III.	Ec. Re.				
9...12 13 A.M.	I.	Ec. Re.				
9 08 P.M.	I.	Tr. Eg.				
9 24 "	I.	Sh. Eg.				
13... 9 39 "	IV.	Tr. In.				
15... 9 30 "	III.	Oc. Dis.				
11 25 "	I.	Oc. Dis.				

NOTE.—In. indicates ingress; Eg., egress; Dis., disappearance; Re., re-appearance; Ec., eclipse; Oc., occultation; Tr., transit of satellite; Sh., transit of shadow.

Occultations Visible at Washington.

Date.	Star's Name.	Magni- tude.	IMMERSION.			EMERSION.			Dura- tion. h m
			Wash.	Angle f'm	N. P't.	Wash.	Angle f'm	N. P't.	
			h m			h m			
June 22	<i>i</i> Leonis.....	5½	8 14	28	Star 1.5' N. of Moon's limb				
26	80 Virginis.....	6	7 47	35	Star 0.5' N. of Moon's limb				
July 1	λ Sagittarii.....	3	11 46	139		12 41	228		0 56
2	β^1 Sagittarii.....	6	12 18	40		13 14	308		0 56
2	β^2 Sagittarii.....	4½	12 26	81		13 44	265		1 18
5	τ^1 Aquarii.....	5½	14 21	88		15 33	220		1 12
5	τ^2 Aquarii.....	4	15 49	44		17 03	270		1 14
11	B.A.C. 1206.....	6	14 50	45		15 47	266		0 57
24	95 Virginis.....	6	7 40	114		8 58	305		1 18
24	α Virginis.....	4	12 05	186		12 18	213		0 13
28	63 Ophiuchi.....	6½	10 26	141		11 21	227		0 54
31	χ Capricorni.....	5½	8 14	32		8 57	310		0 43
31	ϕ Capricorni.....	5½	12 27	340	Star 2.0' N. of Moon's limb				
Aug. 3	33 Piscium.....	4½	9 08	10		9 33	312		0 25
3	B.A.C. 17.....	6	11 23	36		12 23	272		1 00
7	B.A.C. 1119.....	6	14 26	48		15 35	256		1 09
9	η Tauri.....	5½	12 51	77		13 45	250		0 54

*Multiple star.

Phases of the Moon.

					Central Time.	
					d	h m
New Moon.....	1890	June 17	3 58	A. M.		
First Quarter.....	"	"	25	7 54	"	"
Full Moon.....	"	July 2	8 23	"	"	"
Last Quarter.....	"	"	8 10	43 P. M.	"	"
New Moon.....	"	"	16	6 50	"	"
First Quarter.....	"	"	24	8 44	"	"
Full Moon.....	"	"	31	3 24	"	"
Last Quarter.....	"	August 7	8 19	A. M.	"	"
New Moon.....	"	"	15	10 20	"	"

Minima of Variable Stars of the Algol Type.

	R. A.			Decl.	Approx. Central Times of Minima.
	h	m	s		
U Cæphei.....	0	52	32	+ 81 17	July 1, 3 A. M.; 6, 3 A. M.; 11, 3 A. M.; 16, 2 A. M.; 21, 2 A. M.; 26, 2 A. M.; 31, 1 A. M.; Aug. 5, 1 A. M.; 10, 1 A. M.; 14, midn.
Algol.....	3	01	01	+ 40 32	July 9, 1 A. M.; 29, 2 A. M.;
λ Tauri.....	3	54	35	+ 12 11	Aug. 5, 4 A. M.; 9, 3 A. M.; 13, 2 A. M.
U Coronæ.....	15	13	43	+ 32 03	July 7, 2 A. M.; 13, 11 P. M.; 20, 9 P. M.
U Ophiuchi.....	17	10	56	+ 1 20	June 19, 3 A. M.; 19, 11 P. M.; 24 midn.; June 25, 8 P. M.; 29, midn.; 30, 8 P. M.; July 5, 1 A. M.; 5, 9 P. M.; July 10, 2 A. M.; 10, 10 P. M.; 15, 11 P. M.; 20, midn.; 21, 8 P. M.; 26, 11 P. M.; 31, 1 A. M.; 31, 9 P. M.; Aug. 5, 2 A. M.; 5, 10 P. M.; 10, 11 P. M.; 15, 11 P. M.

COMET NOTES.

Another Lost Comet. The veteran comet seekers, Swift and Brooks, both report many unsuccessful searches for Brorsen's comet. Its course this year was favorable for its detection. Has this comet suffered the fate of Biela's comet?

Comet 1890 I (Borelly). Ensign H. S. Chase, U. S. Navy, has computed the following elements of this comet from observations on dates Dec. 12 and 21, 1889, and Jan. 3, 1890 (*Astr. Jour.* No. 217):

$$\begin{aligned} T &= 1890 \text{ Jan. 26. } 260373 \text{ Wash. M. T.} \\ \pi &= 208^{\circ} 15' 06.8'' \\ \Omega &= 8 \ 17 \ 11.2 \\ i &= 56 \ 42 \ 25.4 \end{aligned} \left. \vphantom{\begin{aligned} T \\ \pi \\ \Omega \\ i \end{aligned}} \right\} 1890.0$$

$$\log q = 9.430882; q = 0.269700$$

Comet 1889 I. The following ephemeris, from *Astr. Nach.* No. 2962, is continued from last month:

Berlin Midnight	α app.	δ app.	$\log. r$	$\log. \Delta$	Brightness.
	^h ^m ^s	[°] ['] ^{''}			
June 16	17 43 55	-6 51.2			
18	41 42	6 51.0			
20	39 30	6 50.9	0.7570	0.6754	0.85
22	37 19	6 51.0			
24	35 09	6 51.4			
26	33 01	6 52.0			
28	30 55	6 52.7	0.7621	0.6836	0.79
30	28 52	6 53.6			
July 2	26 51	6 54.8			
4	24 51	6 56.1			
6	22 56	6 57.6	0.7671	0.6936	0.74
8	21 02	6 59.3			
10	19 11	7 01.1			
12	17 23	7 03.1			
14	15 38	7 05.2	0.7720	0.7052	0.69
16	13 56	7 07.5			
18	12 18	7 10.0			
20	10 42	7 12.6			
22	09 10	7 15.3	0.7769	0.7180	0.64
24	07 41	7 18.2			
26	06 16	7 21.2			
28	04 54	7 24.3			
30	03 35	7 27.5	0.7817	0.7318	0.59
Aug. 1	02 20	7 30.8			
3	01 08	7 34.3			
5	17 00 00	7 37.8			
7	16 58 56	7 41.4	0.7864	0.7463	0.54
9	57 55	7 45.1			
11	56 58	7 48.9			
13	56 04	7 52.8			
15	16 55 13	-7 56.7	0.7911	0.6708	0.49

Mr. E. E. Barnard sends an interesting note on this comet.

Comet 1890 ... (Brooks, March 19). Several sets of elements of this comet have come to hand. The following by Herr Bidschof (*Astr. Nach.*

No. 2966) depends upon observations dated March 21, April 3, and April 18:

$$\begin{array}{l} T = 1890 \text{ June } 1.1529 \text{ Berlin M. T.} \\ \omega = 68^{\circ} 36' 10.7'' \\ \Omega = 320 \quad 17 \quad 18.6 \\ i = 120 \quad 27 \quad 53.5 \end{array} \left. \vphantom{\begin{array}{l} T \\ \omega \\ \Omega \\ i \end{array}} \right\} 1890.0$$

$$\log. q = 0.281482; q = 1.91197.$$

From these elements Mr. O. C. Wendell has computed the ephemeris given below for June. The comet is easily picked up with a small telescope, but will not become visible to the naked eye. It has a sharply defined nucleus of about the 10th magnitude, the nebulosity about it growing rapidly fainter. The tail is exceedingly faint, but can be traced for about 1° from the nucleus.

Ephemeris of Comet a 1890, Brooks (March 19). From Bidschof's elements as given in A. N. 2966, p. 239, I have computed the following ephemeris:

Gr. M. T.	App. R. A.	App. Dec.	Log. r	Log. Δ
	^h _m			
June 1.5	19 19.2	+ 58 30	0.2815	0.1963
2.5	19 12.0	59 18		
3.5	19 4.3	60 4		
4.5	18 56.2	60 48		
5.5	18 47.7	61 30	0.2817	0.1960
6.5	18 38.8	62 9		
7.5	18 29.5	62 46		
8.5	18 20.0	63 19		
9.5	18 10.0	63 49	0.2821	0.1988
10.5	17 59.6	64 16		
11.5	17 49.0	64 39		
12.5	17 38.3	64 59		
13.5	17 27.4	65 16	0.2829	0.2044
14.5	17 16.3	65 28		
15.5	17 5.2	65 37		
16.5	16 54.0	65 37		
17.5	16 43.0	65 44	0.2839	0.2125
18.5	15 32.2	65 42		
19.5	16 21.6	65 37		
20.5	16 11.1	65 29		
21.5	16 0.9	65 18	0.2853	0.2228
22.5	15 50.9	65 5		
23.5	15 41.2	64 50		
24.5	15 32.0	64 33		
25.5	15 23.1	64 12	0.2869	0.2347
26.5	15 14.7	63 50		
27.5	15 6.8	63 25		
28.5	14 59.5	62 57		
29.5	14 52.9	62 27	0.2887	0.2484
30.5	14 47.1	+ 61 55		

Harvard College Observatory, May 17, 1890.

O. C. WENDELL.

The Longest Known Duration of Visibility of a Comet, I 1889. I have thought you would care to know that the comet discovered here on September 2, 1889, = I 1889, is still easily visible in the 12-inch refractor, and the chances are that it will be followed until September, thus making its known visibility extend over two years. It is now nearly twenty-one

months since its discovery. This of course carries its duration of visibility far beyond anything ever known before—five months longer than that of the great comet of 1811 which was the longest known previous to this.

The comet is now four hundred and twenty-seven millions of miles from the earth and five hundred and four millions from the sun. The apparent place of the comet this morning was

$$\alpha = 18^{\text{h}} 18^{\text{m}} 34.9^{\text{s}} \quad \delta = -7^{\circ} 21' 57''$$

at Mt. Hamilton, May 15, $14^{\text{h}} 50^{\text{m}} 21^{\text{s}}$ from filar micrometer comparisons with the star Schj. 6690. This gives the following correction to Berberich's ephemeris in A. N. 2962:

$$\text{In } \alpha, +5^{\text{s}}; \quad \text{in } \delta, -1.9'.$$

See SIDEREAL MESSENGER for May, p. 227.

E. E. BARNARD.

MT. HAMILTON, MAY 16, 1890.

Comets of Short Period. A very interesting paper by M. Schulhof of Paris, entitled "Notes on Some Comets of Short Period," is contained in *Astr. Nach.* No. 2964. It is a discussion of the possible identity of several pairs of periodic comets by means of the criterion discovered by M. Tisserand and noticed in an article in this journal pp. 128 and 129. He finds the identity of Comet Finlay 1886 VII with Lexell 1770 more probable than that of Comet Brooks 1889 V with Lexell 1770. We may suggest that possibly both 1886 VII and 1889 V may be parts of Lexell 1770, as the latter may have suffered disruption by passing through Jupiter's system of satellites in 1779, just as the Brooks comet seems to have been divided in 1886.

Mr. Schulhof also discusses the possible identity of comets Finlay 1886 VII and De Vico 1884 I, Denning 1881 V and Pigott 1783, Blanpain 1819 and Grischow 1743, Coggia 1873 VII and Pons 1818 I, Biela and Pons 1818 I, Winnecke and Helfenzrieder 1766 II., reaching a certain negative conclusion in the case of only the second pair.

Annular Eclipse of the Sun.—An annular eclipse of the sun will take place on June 17. It will not be visible in America, the path of the annular eclipse beginning in the Atlantic ocean, passing across Northern Africa, the Mediterranean Sea, Turkey, Persia, Hindostan, ending in Siam.

Lunar Appulse. Forty-five minutes after midnight of June 2, the moon will pass so close to the edge of the earth's shadow that it is doubtful whether the edge of the moon will enter the shadow or not. The angle of position of the point of approach from the north point of the disk is 167° toward the west.

New Planetoids. Two new planetoids were discovered on April 25 by Palisa at Vienna. Their numbers are 291 and 292. Professor Krueger thinks that No. 292 is probably a rediscovery of Scylla, No. 155, found by Palisa in 1875. The two were very near together, the position of one being on April 25, R. A. $14^{\text{h}} 21.1^{\text{m}}$, Decl. $-11^{\circ} 06'$; that of the other R. A. $14^{\text{h}} 19.6^{\text{m}}$, Decl. $-10^{\circ} 40'$. They were discovered independently on April 26 by Charlois at Nice. Another of the 13th magnitude was discovered by Charlois May 20.5784, in R. A. $16^{\text{h}} 20^{\text{m}} 55^{\text{s}}$, Decl. $-22^{\circ} 39' 02''$.

Solar Prominences for April.—Number of observations, 14. Number of prominences, 43. Mean, $3\frac{1}{4}$. Greatest number in one day, 6 on the 29th. Least number in one day, 1 on the 1st. Highest prominences, 54" on 20th and 28th.

DISTRIBUTION IN LATITUDE.

				E.	W.					E.	W.
Between	0 A.M.	10	4	2	Between	0 A.M. — 10	1	2			
+ 10 "	20	4	2	2	+ 10 "	20	1	3			
20 "	30	..	..	..	20 "	30	2	1
30 "	40	..	..	..	30 "	40	..	..	
40 "	50	..	..	..	40 "	50	..	2
50 "	60	..	..	..	50 "	60	..	2
60 "	70	..	..	..	60 "	70	4	4
70 "	80	..	..	..	70 "	80	3	4
+ 80 "	80	7	2	2	+ 80 "	90	25	18			
Camden Observatory.											

Smith Observatory Observations. The following solar observations have been made with helioscope, except when otherwise specified. Those of April 16th were made by Mr. F. M. Jack.

On 12th and 13th May the sun was glimpsed for a moment only, although watched all day, but it was impossible to count spots accurately.

1890.	90° Mer.	Groups.	Spots.	Faculae.	Seeing.	Remarks.
	M. T.					
12 April.	1 P. M.	4	10	1 gr.	Good.	Fac. about 3d gr. spots.
13 "	1 "	0	0	0	Clouds.	Nothing distinct visible.
14 "	11.15 A. M.	0	0	1	Poor.	Gran. difficult.
15 "	11.45 "	1	3	1	Fair.	Fac. disturbance around spots.
16 "	10.30 "	1	3	1	Very good.	Gran. good.*
17 "	12 M.	0	0	1	Fair.	Gran. good.
18 "	11.20 A. M.	0	0	1	Poor.	Gran. fair.
19 "	2.15 P. M.	0	0	2	Bad.	Gran. dif.; limb very unsteady.
20 "	12 M.	0	0	0	Poor.	Larger gran. fair.
21 "	11 A. M.	0	0	0	Fair.	Light haze too indistinct for faint spots.
22 "	11.30 "	0	0	2	Good.	Fac. faint on E. and W. limbs.
23 "	11.30 "	0	0	0	Poor.	Gran. dif.
24 "	12 M.	0	0	0	Poor.	Gran. dif., limb unsteady.
25 "	11.30 A. M.	0	0	0	Bad.	Seeing almost impossible; haze.
27 "	12.30 "	0	0	0	Bad.	Gran. indistinct.
28 "	2 P. M.	1	1	0	Fair.	Small and indistinct.*
29 "	12.15 "	2	4	0	Poor.	2 masses nuclei, 2 tiny veiled spots between.
30 "	9.15 A. M.	2	12	0	Poor.	1 faint veiled spot between groups.
1 May.	11.30 "	0	0	0	Bad.	Impossible to make out anything.*
2 "	5.30 P. M.	0	0	1	Good.	Gran. good.
3 "	3.00 "	0	0	1	Fair.	Fac. near S. W. limb.
6 "	2.30 "	0	0	0	Bad.	Clouds; indistinct.
7 "	11.45 A. M.	1	2	1	Good.	Spots very minute; Fac. E. limb.
8 "	2 P. M.	2	5	1	Good.	Fac. around spot centres.
10 "	2.30 "	2	12	0	Very good.	Small gran. very distinct.
11 "	3.30 "	3	17	2	Very good.	Fac. near N. E. limb; and W. gr. spots.
12 "	11.54 A. M.	2	?	0	Bad.	Single glimpse through clouds; gen. app. unchanged.
13 "	1.30 "	2	?	0	Clouds.	Groups fainter, unable to count spots.
14 "	5.20 "	0	0	2	Good.	Fac. near E. and W. limbs.
15 "	11.45 "	0	0	0	Poor.	Gran. fair.

* Projection on 20 cm. circle.

Smith Observatory, Beloit College,
May 15th, 1890.

CHAS. A. BACON.

Associate Solar Phenomena. The accompanying table has in the first column the dates on which faculae appeared by rotation on the sun, as determined by the observations published in *THE SIDEREAL MESSENGER* and the *Monthly Weather Review*, supplemented in one or two instances by the observations of the writer. In the second column are indicated the extent of magnetic perturbations as shown by the declination magnetograph at the Naval Observatory, Washington. In the third column are given the numbers of stations daily reporting auroras to the signal service bureau, and in the fourth column the extent of thunder-storms as described in the *Monthly Weather Review*.

This table is not intended to give anything more than a concise summary of such information as is at hand at the present writing for three months named, so as to indicate the points with reference to which further observations may be desirable. In general it appears that when solar disturbances are at or near the eastern limb there is a manifest increase in auroras and magnetic storms. The exception on Jan. 20th is more apparent than real, as is shown by the fact that at the next return on Feb. 14th and 15th groups of faculae were visible at the eastern limb, and there was a recurrence of magnetic perturbations and auroras. The other exceptional case on Feb. 24th is of a different character. On this date there was no increase in magnetic perturbations and auroras, although faculae appeared by rotation. Thunder-storms, however, attained their maximum, which corresponds to what has been observed in many other instances indicating that there is a reciprocal relation between these phenomena, the one taking the place of the other at times.

It is noteworthy also that the maxima of auroras on Jan. 17th and following days corresponds to that on Feb. 11th and following days at an interval corresponding precisely to the time of the rotation of the sun. Such periodicity is very common.

Date.	Solar Condition.	Magnet.	Auroras.	Thunder-storms.
January, 1890.				
1		Calm.		8 States.
2	Faculae by rotation.	Much.	1 Station.	8 States.
3		Much.	1 Station.	1 to 4 States.
4		Slight.		1 to 4 States.
5		Calm.		1 to 4 States.
6		Slight.		1 to 4 States.
7		Calm.		1 to 4 States.
8		Calm.		1 to 4 States.
9	Faculae by rotation.	Moderate.		None.
10	Faculae by rotation.	Moderate.		1 to 4 States.
11		Calm.	1 (Corona)	1 to 4 States.
12		Calm.		11 States.
13		Slight.		1 to 4 States.
14		Calm.		1 to 4 States.
15		Calm.		1 to 4 States.
16	Faculae by rotation.	Calm.		1 to 4 States.
17		Much.	12 Stations.	None.
18		Much.	6 Stations.	1 to 4 States.
19		Calm.		8 States.
20		Much.	2 Stations.	5 States.
21		Slight.	5 Stations.	None.
22		Slight.		1 to 4 States.
23	Faculae by rotation.	Slight.		None.
24		Calm.		1 to 4 States.
25		Calm.		1 to 4 States.
26		Calm.		None.
27		Calm.		None.
28	Faculae (Jan. 2nd area)	Slight.	1 Station.	1 to 4 States.
29		Calm.		1 to 4 States.
30		Calm.	1 Station.	None.
31		Slight.	2 Stations.	1 to 4 States.

Date.	Solar Condition.	Magnet.	Auroras.	Thunder-storms.
February.				
1		Calm.	1 Station.	1 to 3 States.
2	Faculae by rotation.	Moderate.		1 to 3 States.
3		Moderate.		None.
4		Calm.		5 to 11 States.
5		Slight.		None.
6	Faculae (Jan. 9th area)	Calm.	1 Station.	5 to 11 States.
7		Slight.		None.
8		Slight.		5 to 11 States.
9		Calm.		1 to 3 States.
10		Calm.		1 to 3 States.
11	Faculae (Jan. 16th area)	Moderate.	7 Stations.	1 to 3 States.
12		Slight.		1 to 3 States.
13		Slight.	1 Station.	5 to 11 States.
14	Faculae by rotation.	Much.	6 Stations.	5 to 11 States.
15	Faculae (See Jan. 20th)	Moderate.	1 Station.	None.
16		Slight.		None.
17		Much.		5 to 11 States.
18	(Jan. 23rd area)	Much.	1 Station.	14 States.
19		Moderate.		5 to 11 States.
20		Moderate.	1 Station.	1 to 3 States.
21		Slight.		1 to 3 States.
22		Calm.		5 to 11 States.
23		Calm.		20 States (max.).
24	Faculae (Jan. 28th)	Calm.		24 States (max.).
25		Calm.		16 States.
26		Slight.		5 to 11 States.
27		Calm.		
28		Calm.		

M. A. V.

Carleton College Sun Spot Observations. (Continued from page 230.)

Date.	Central Time.	Gr.	Spots.	Fac.	Obs.	Remarks.
April 21	2.20 P. M.	0	0	0	C. R. W.	
23	2.10 "	0	0	0	"	
24	12.20 "	0	0	0	"	
25		0	0	1 gr.	H. C. W.	
26	12.20 "	0	0	1 Sr.	C. R. W.	
28	10.30 A. M.	1	2	0	H. C. W.	
29	12.30 P. M.	1	15	0	"	
30	12.20 "	8	1	1 gr.	C. R. W.	Two parts to the group connected by a dark line.
May 1	12.30 "	1	1	1 gr.	"	
2	12.25 "	0	0		"	
3	4.10 "	0	0	1 gr.	"	
7	12.15 "	0	0	1 gr.	H. C. W.	
10	12.30 "	8	1	1 gr.	C. R. W.	Two large spots. Faculae near the spots.
14	2.05 "	0	0	0	"	
21	1.40 "	2	2	2 gr.	H. C. W.	
23	12.30 "	1	2	0	C. R. W.	
24	1.30 "	0	0	0	H. C. W.	
26	10.00 A. M.	1	2	1 gr.	C. R. W.	
28	3.50 P. M.	0	0	1 gr.	"	
29	12.30 "	0	0	1 gr.	"	

Julian Day. In No. X. of Vol. 18 of the Annals of Harvard College Observatory, we notice a useful table which shows how the Julian day affords a convenient means of determining the interval in days between any two calendar dates. The table is arranged to determine the Julian day of any date in the nineteenth century, and has been found, in practice, a more convenient form than that usually employed.

Mr. Tebbutt's Observatory. The reports of Mr. Tebbutt's Observatory for the years 1888 and 1889 have been received. Their contents describe the Observatory building and instruments, give the geographical position of the Observatory and some account of the Meridian and extra Meridian work, meteorological observations, publications, the library, personal establishment and statement of proposed work for the present year. Though not large volumes these reports show useful astronomical work.

NEWS AND NOTES.

Subscribers will please remember that this journal will not be published for the month of July. The next number will appear for the month of August or September.

Fourth Annual Report, Henry Draper Memorial, Harvard College Observatory. The first investigation undertaken as a memorial to Dr. Henry Draper was the formation of a catalogue of about 10,000 stars north of -25° , and in general brighter than the seventh magnitude, by the aid of the Bathe telescope, eight inches aperture and 44 inches focal length. This investigation is nearly completed. The catalogue and about half of the table giving the details of the observations are already in type. Notes giving the peculiarities of the spectra are completed and in the hands of the printer.

The second investigation relates to the spectra of fainter stars. Photographs with exposures of one hour have been made in nearly all parts of the sky north of -25° , and furnish material for a discussion of spectra of stars brighter than the ninth magnitude. Several thousand of these spectra have been identified and measured.

The expedition under the direction of Mr. S. I. Bailey, which went to Peru, South America, last spring, chose a position on a mountain 6,500 feet high, about 20 miles east of Lima. During the first six months the weather was good, and about 1,300 photographs were obtained, and each of four principal researches were about half completed. The first series of photographs taken by the Bathe telescope furnish charts of the entire sky south of -25° , using exposures of ten minutes. All stars brighter than the tenth magnitude will thus be photographed. A second set of charts having exposures of an hour cover the same regions, and include stars brighter than the fifteenth magnitude. This interesting report then describes a number of the more remarkable southern objects, such as the nebula around η Argus, the Trifid nebula, N. G. C. 6533, etc. The most important work of the eleven-inch telescope has been the study of the spectrum in which the K line is occasionally double. In the case of ζ Ursæ Majoris this appeared to take place at intervals of fifty-two days. An explanation of this curious phenomenon is furnished by supposing that the star is a close binary the maximum velocity of whose components is about one hundred miles per second. The spectrum of β Aurigæ exhibits a similar peculiarity. The maximum separation indicates a relative velocity of one hundred and fifty miles per second and it occurs with great regularity. A period of four days is indicated, and a nearly circular orbit. This corresponds to a distance between the components of about 8,000,000 miles, and a combined mass of two and three tenths times that of the sun. This report has as a frontispiece a fine lithograph plate showing the spectrum of this last named star with K line both single and double.

Bright Streaks from the Craters of the Moon. In the May number of *Knowledge*, Editor A. C. Ranyard has an article on the great bright streaks which radiate from some of the larger lunar craters. This paper refers to

another of like interest published last October by Mr. Ranyard in the same journal giving reasons to support the view that the surface of the moon is covered with snow, or ice and hence the unchanging color so commonly reported by all observers. Starting with this view Mr. Ranyard discusses the possible causes of these radiating streaks. He has to aid him a fine full page illustration of one of the photographs of the moon taken by the great refractor of Lick Observatory. He supposes, as shown in the former article, that the polar caps, like those seen in Mars, have extended towards the equator, and there met; that the great whiteness of the higher portions may thus be accounted for; that the darker color of lower levels may be due to the mixture of rock, debris and moving snow and ice. In these articles the author gives the different views of astronomers commonly held, and to them adds the above as suggestions rather than definitely formed opinions.

The three following paragraphs are from the Publications of the Astronomical Society of the Pacific, No. 8. (May 31, 1890.)

Note on Photographing the Dark Part of the Moon. It is found by experiments made on the evening of April 21 that the dark part of the moon, when the moon's age is 2.9 days, can be photographed with the 12 inch equatorial with a seed 26 plate in 20 seconds the complete outline of the dark part just showing with this exposure. With 40 seconds and 70 seconds the dark part was conspicuous and details on it were clearly shown.

E. E. B.

Copies of Photographs taken at the Lick Observatory—How to obtain them. The Director of the Lick Observatory has been authorized to furnish copies of some of the negatives taken at Mount Hamilton to certain photographers, in order to make such copies available generally. Copies of some of our negatives have been furnished to quite a number of firms accordingly. Some of these firms (I. W. Taber, 8 Montgomery Street, San Francisco; Hill & Watkins, Santa Clara Street, San Jose, and Gayton A. Douglas & Co., 185 Wabash Avenue, Chicago,) are prepared to furnish prints, enlargements and lantern slides from such negatives as they now have. Other negatives will be furnished to them from time to time.

E. S. H.

Companion of Sirius.

P = 359°.6	D = 4".17	1890.252
361 .6	4 .20	.259
256 .8	4 .19	.304
359 .7	4 .19	1890.27

These measures were made with the 36-inch equatorial. S. W. B.

Observatory of Paris. The annual report of the Director of the Observatory of Paris for the year 1889 has just come to hand. It contains an account of the Photographic Congress which met at the Observatory in September, the work which has been done with various instruments by the large corps of observers, a description of the great *Equatorial Coude*, 59 feet focal length, 23.6 inches aperture and various other matters of interest.

The Iowa Meteor. Late in the afternoon of Friday, May 2, a brilliant meteor was seen in Northern Iowa, Southern Minnesota and South Dakota. At Northfield the meteor was observed S. 30° W. at a height of about 40° , and disappeared near the horizon, behind trees, S. 20° W. Its duration was about 5^s. Intensely bright, although no distinct head could be seen, but part of its path was brighter than the moon. Its motion appeared to be in the arc of a great circle passing through the north pole, with a length of about 30° . Time of observation was 5^h 10.5^m.

From Alta, Iowa, Mr. David E. Hadden reports: A brilliant meteor was observed here about 5.10 o'clock, Central time, on the afternoon of May 2d. It appeared to emanate from a point in altitude 35° , azimuth 170° , and traveled rapidly in a nearly straight line to a point in altitude 10° , azimuth 250° (approximately,) when it disappeared. Although in full sunlight and a cloudless sky, the meteor was a conspicuous object, being unusually large and of an intense greenish white color at first, changing at disappearance to a bright red. It left a long trail, which remained distinctly visible for over 45 minutes. No sound was heard to accompany it."

At Sioux City, Iowa, it was seen at 5^h 45^m, passing northwest of the city. It appeared at an elevation of 25° , seemed to burst three times, and then disappeared. The time of its appearance at Mason City was reported at 5^h 15^m, moving nearly east, and the report it made in passing through the air is likened to that of cannon by the people who heard it. Its path was a long streak of fire and smoke. People were greatly excited and sought to find its fall. At Algona the meteor was reported to pass at 5^h p. m., with a noise like thunder. At Wells, Minnesota, it was seen, and the noise was like thunder. It was very bright, although the sun was shining at the time. A streak of blue smoke was left behind it. The meteor was plainly seen at Lake Benton, Currie, Sioux Falls, Forest City, Britt, Emmetsburg, Ruthven, and a large number of other places. There seems to be little doubt that there were several explosions of the meteor while over Northern Iowa, and possibly some in Southern Minnesota if reports can be relied on.

The experience of a representative of the University of Minnesota in attempting to secure some of the precious fragments of this brilliant visitor has been matter of amusing conversation and general interest in literary and legal circles hereabouts for the last few weeks. The representative above referred to soon found the locality, a few miles from the south line of Minnesota, where some pieces of the meteor had fallen, on a farm in the possession of a man by the name of Anderson, who doubtless esteemed his prize of some value. Others interested in buying the fragments were also soon at the same place with the determined purpose of becoming owners of all aerial stones that Mr. Anderson or any one else had to dispose of by auction or otherwise. Very soon the interest ran so high in securing the largest piece of the meteor that bidding between two persons ran up to over one hundred dollars, and the representative of the University of Minnesota was the successful competitor. This large fragment was boxed and taken to the nearest railroad station, and the aerolite hunters went in search of more fragments. In the mean time new and unforeseen difficulties arose. Mr. Anderson, who had sold the meteor and received the money,

was only lessee of the ground where the meteor had fallen, and not the owner of it, so the rightful owner, with officer and papers suddenly appeared at the station where the meteor was lodged for transportation, and took possession of this piece of Iowa property, and immediately made away with it. The Minnesota scientist with alacrity secured Minnesota council, and thus legally armed renewed the exciting contest. After the necessary formal and official parley the meteorite and its purchase money were taken possession of by the representatives of the law, and a case will soon be argued in court to decide whether a lessee of land or the fee owner has title to an aerolite that has fallen during the time of lease. This case parallels a similar one mentioned in Langley's *New Astronomy* page 187.

While this question is being settled, it will be of interest to scholars in this branch of astronomy to know that Professor Weld, of Iowa State University, is industriously collecting all data he can to determine the orbit of the meteor, and its physical characteristics. Any information to aid him in this will be gratefully received.

Origin of Aerolites. Since the fall of the fragments of the Iowa aerolite on the afternoon of May 2, considerable has appeared in current local newspapers pertaining to the origin of aerolites and phenomena accompanying them within the range of observation. We are indebted to Mr. D. G. Parker of Albert Lea, Minn., for some articles bearing on this theme that we would not otherwise have seen. With him we are surprised that any prominent scholar should now hold that the origin of aerolites is from the moon. Some writers, as Mr. Proctor, have held that meteors, including meteorites, aerolites and other bodies named as belonging to this common family, are due, probably, to the eruptive force of the sun. But this view, plausible as it may seem, is not commonly held by astronomers of the present day. As Mr. Parker claims, in a well written article appearing May 22 in the *Freeborn County Standard*, meteors are independent bodies moving in orbits of their own in space, that these dark bodies are abundant in the interplanetary spaces, that those within the near range of solar or planetary attraction move with great velocity, that many swarms of them follow well known orbits, and that, in general, their origin is undoubtedly the same as that of other celestial bodies. For authorities the reader is referred to Young's *General Astronomy*, Chambers' *Handbook of Astronomy*, Edmund Beckett's *Astronomy without Mathematics*, Ball's *Story of the Heavens*, Winchell's *World Life and Comparative Geology*, Langley's *New Astronomy*, and many others that might be easily named.

United Astronomical Research. It is a pity that all available means for the improvement of American Astronomy are not put to wise and productive use. The number of small telescopes in all parts of the country, the host of amateur observers who are willing to devote time in useful work, and the general public interest in popular astronomy are enough to awaken thought and desire to devise some plan by which so much valuable energy might be turned into proper channels, instructed and utilized. How easy it would be for anyone having a small telescope to devote himself to some one line of observation, and conscientiously persevere in securing and

making a complete record for some period of time suitable for the study. Such a course would certainly increase interest in reading and knowing all that could be learned in the special line of observation, and very likely bring to the attention, some new things about it, that may have escaped the notice of older and wiser ones in science.

There is not a single line of astronomical study that might not be profitably pursued in such a plan as this. The simple question is, are the young or amateur observers willing to undertake some simple line of observation and persistently follow it, for the sake of making a complete record of what may be seen and what ought to be recorded? In reply to this we fancy some student is ready to say that he would gladly undertake such work if he knew what to do or how to do it. If there are such we desire to know their names, what kind of a telescope they have, and if they have tried any regular observing. It is not necessary that an observer should devote a *great* deal of time daily, but it is important that all such work should be done well, systematically and thoroughly. We do not see why a score of young observers could not be continually doing useful work, and thereby gaining for themselves knowledge, facility and skill in astronomy that can not possibly be secured in any other way. If a plan like this interests any of our readers they are respectfully asked to correspond with us concerning it. Possibly this matter may be considered of sufficient importance to find place in the councils of the proper section of the American Association for the Advancement of Science at its next meeting in Indianapolis. The further question of unifying the regular astronomical work of the United States is certainly a subject that ought to claim the attention of Astronomers and others directly or indirectly interested.

Lightning Spectra. Mr. W. E. Woods of Washington, D. C., under date of May 16, writes of his use of a Browning's Pocket Spectroscope in the study of the spectra of lightning during a thunder storm. In several instances he observed the spectra of flashes which appeared as bright lines superposed on a faint continuous spectrum. In each case, when the continuous spectrum was bright enough to be seen, shaded flutings were visible. An interesting diagram of observations accompanied Mr. Wood's letter. We hope to be favored by further studies of this kind.

Reversed Curvature of Shadow on Saturn's Rings. Elsewhere will be found an article by Mr. Aldro Jenks on the reversed curvature of the shadow on Saturn's rings. There is probably no doubt of the correctness of the observations reported, for the same thing has been seen by experienced observers before. The theory proposed by Mr. Jenks for the explanation of the same is novel, and without any analogy to support it, yet his is the honest effort of an amateur to account for a phenomenon before not even attempted so far as we know.

Algol System. In a communication to the MESSENGER sent from this place last month, I made a suggestion that the variability of Algol's period might be due to an orbital motion of the Algol system, as now almost established, around a central invisible body.

Before my article could have reached you there was already in type, what I now read in *THE MESSENGER* with intense interest: Professor Vogel's announcement of the proper motion of the Algol system. This is precisely the information I hoped to obtain, as already stated, many years ago.

Now if the motion of Algol toward us is coincident with the shortening of its period of variation, it may be expected that when, in the course of the long observed fluctuations, this period shall lengthen, Algol will be found to be receding from us. Let this be proved, and the existence of a revolution around a central controlling force seems to be an inevitable conclusion.

WM. CURTIS TAYLOR.

Tacoma, Wash., May 8, 1890.

Photographic Notes. *The Observatory* for May contains a paper by A. A. Common on "The Photographic Chart of the Heavens." In discussing means of securing uniformity of development of plates, Mr. Common recommends a system of squares similar to that introduced by Capt. Abney for measuring the photographic intensity of light. As to the position of the plate, it is suggested that it should be in the middle of the tube of the photographing telescope.

The same number of *The Observatory* states that MM. Henry strongly recommend the following method for preventing halos about the photographic images of bright stars: "Coat the back of the plate with normal collodion, containing a little chrysoidine. This is of almost the same refractive index as glass, and completely suppresses halos even with the brightest stars."

Monthly Notices for March publishes an article by Mr. E. E. Barnard, "On Some Celestial Photographs Made with a Large Portrait Lens at the Lick Observatory." Mr. Barnard attached such a lens of 5.9 inch aperture to a 6½ inch equatorial, using the equatorial as a following telescope; exposures were made on the Milky Way, the Pleiades, and the Great Nebula of Andromeda. In regard to the results Mr. Barnard writes: "For many years I have observed in my comet seeking a most remarkable small inky black hole in a crowded part of the Milky Way. . . . Not only is the black hole clearly shown in this negative, but the entire cloud-like formation about it, in which myriads of stars are all faithfully depicted. The exceeding beauty of a glass positive from this plate is beyond description. . . . I have made reduced copies of the above negatives. The result is striking. In the Milky Way pictures, the cloud-like masses of stars stand out more boldly, and their forms are more definite than in the original. Reduced in this way the picture of the region of the Andromeda nebula is singularly beautiful, and it shows in a most remarkable manner the peculiar structure of that part of the heavens. The intricate arrangement of the stars in rings and segments are thus shown as nothing else can show them."

Mr. Isaac Roberts' photographs of clusters 33 and 34 H V1 Persei, in which he finds no trace of nebulosity, suggest to him a possible "classification of some of the stages in the evolution of the universe" through a study of the different nebulosities of clusters.

Bulletin No. 13 U. S. Scientific Expedition to West Africa. Under date of March 13, 1890, Professor Cleveland Abbe, of the United States Signal Service, member of the Scientific Expedition, under Professor Todd, issued Bulletin No. 13, with title, "Localities of Scientific Interest in St. Helena." In it are found references to the work of Edmund Halley (1676), who compiled the first catalogue of southern stars, 341 in number, and who observed a transit of Mercury Nov. 7, 1677. Also are given references to work done by Abraham Sharp, Maskelyne and Waddington, John Macdonald, Captain Henry Foster, and a dozen others who have made useful contributions to science from this historic island.

Gainesville Meteor. A meteor weighing several hundred pounds fell at Gainesville, Texas, in the yard of S. P. Hargis, who lives near here, on the evening March 19. The meteor had the appearance of a huge flint rock, and its flight through the air caused a roaring sound which was heard several seconds before it struck the earth and which resembled distant thunder. It exploded with a report like a cannon while still in the air, and fragments of the stone were scattered for rods around. The main body of the strange visitor struck about fifty feet from Mr. Hargis' house with such force as to imbed itself deeply in the ground.—*Chicago Tribune.*

BOOK NOTICES.

A HAND-BOOK OF DESCRIPTIVE AND PRACTICAL ASTRONOMY, by George F. Chambers, F. R. A. S.

II. INSTRUMENTS AND PRACTICAL ASTRONOMY. Fourth Edition. Oxford: At the Clarendon Press. 1890, 8vo, pp. 558.

The first volume of the fourth edition of Chambers' Hand-book of Descriptive and Practical Astronomy was published in September, 1889, and notice of it has already appeared, with brief explanation of the plan on which the entire revision of the the third edition of this important hand-book would go forward. The second part, which is titled "Instruments and Practical Astronomy," is now before us.

A fine Woodbury-type of the new 30-inch refractor of the Pulkowa Observatory forms the frontispiece. The mounting of the telescope, by Repsold & Sons, and the various appliances for work, in the great dome, show with good advantage.

The contents of this part are divided into four books, numbered consecutively from similar divisions in the first part. Book VII. treats of practical astronomy, discussing, in separate chapters, the following topics, viz.: the telescope and its accessories; telescope stands; the equatorial; the transit instrument; the sextant; miscellaneous astronomical instruments; the observatory; practical hints on the conduct of astronomical observations; history of the telescope.

Book VIII. presents spectroscopic astronomy and the topics are spectroscopy as applied to the sun; as applied to planets and comets; to stars and nebulae; maps of the spectrum.

Book IX. is devoted to astronomical photography.

Book X. presents chronological astronomy, (1) in respect to time generally; (2) subdivisions of time; (3) the almanac; (4) cycles.

Book XI. gives a brief sketch of the history of astronomy.

Book XII. treats of astronomical bibliography, giving a list of published star catalogues and celestial charts, also a list of books relating to reading on astronomy.

Book XIII. contains a series of useful astronomical tables, followed by a vocabulary of definitions, and an index designed for use in connection with the table of general contents.

It is not necessary to speak of the treatment of the various topics of this work in detail, for those already acquainted with former editions, because they know of the thorough study the author has made of the whole subject and the varied sources of general information which he has put under tribute to make a complete hand-book for use in astronomy. But, for those of our readers who are not acquainted with Professor Chambers' books, something ought to be said about the details of this book, to aid in a proper judgment of it. Any part of this volume might be chosen for this purpose with equal propriety, and so we call attention to the first chapter, whose title is "Telescope and Its Accessories." The order of this theme is as follows: Two kinds of telescopes, reflecting, the Gregorian reflector, the Cassegrainian, the Newtonian, the Herschelien, Lord Rosse's large reflector, Nasmyth's reflector, Browning's mountings for reflectors, adjustments for reflectors, refracting telescopes, refractors and reflectors compared, spherical aberration, chromatic aberration, tests for both, theory of

achromatic combinations, tests of a good object glass, the dyalite, the Galilean refractor, eye-pieces, the positive eye-piece, the negative, formulæ for calculating the focal lengths of equivalent lenses, Kellner's eye-piece, the Barlow lens, the terrestrial eye-piece, the pancreatic terrestrial eye-piece, Grubb's prismatic terrestrial eye-piece, Ramsden's dynamometer, Berthou's dynamometer, Dawe's rotating eye-piece, the diagonal eye-piece Dawe's solar eye-piece, Hilger's solar eye-piece, the polarizing solar eye-piece, Airy's eye-piece for atmospheric dispersions, micrometers, the reticuled micrometer, the parallel wire micrometer, the position micrometer, measurement of angles of position, Grubb's duplex micrometer, bright wire micrometer, Bidder's micrometer, Burnham's micrometer, the double image micrometer, the ring micrometer, the square bar micrometer, the zone reticule, slipping piece, telescope tubes.

Forty-seven pages are devoted to this chapter, and thirty-eight cuts appear in connection with the descriptive matter. They are neat in design, clear, well finished, without the idea of extra or far-fetched embellishment, but intended to serve the definite purpose of illustrating what the author is talking about. This art of choosing and designing plates and cuts to illustrate scientific thought and work is so often the weak point in good books that ability in any ought to be recognized and commended. In this chapter and throughout the book the author has given deserved attention to and illustration of American work in astronomy, and we believe this volume will find a large sale on this side because it is so well adapted to the wants of a large number of students in astronomy who either own or have access to and use astronomical instruments. Professor Chambers is to be congratulated in the success he has already realized in the revision of this, the leading handbook of astronomy in the English language.

OUR INHERITANCE IN THE GREAT PYRAMID. With Twenty-five Explanatory Plates, Showing the more Crucial Parts of this really Anti-Egyptian and most Primeval Structure, in Plan, Elevation, and Section. By C. Piazzi Smyth, F. R. S. E., F. R. A. S., Late Astronomer Royal for Scotland. London, Messrs. Charles Burnet & Co., Publishers, 9 Buckingham Street, Strand, 1890. Fifth Edition. 452 pp.

We have not before seen this book, though it has passed through its fifth edition, and has long been well known in scientific and literary circles, in both the Old World and the New. This edition retains the whole of the twenty-five fine and instructive plates of the former editions, but the letter-press has been reduced from 664 to 445 pages, and yet there have been incorporated into the latter 31 pages of appendices, mostly by new authors, showing rather forcibly how the sacred and scientific pyramid theory of John Taylor is now being pursued, not only by Anglo-Saxon, Anglo-Israel, North American, and Great Britain, but also by Belgium in the use of the French language.

The plates, before referred to, are full-page, printed in colors, and precede the text, and very helpfully illustrate the details of the Great Pyramid, which has been so carefully studied by many interested scholars to learn all that might be known about its strange and wonderful symbolism. The book is divided into five parts, presenting, in order, the geography and exterior of the Great Pyramid, history and interior of it, national weights and measures, also those of the Great Pyramid, a meaning in its symbols beyond that of ordinary science, and, finally, the personal and the future of the Great Pyramid.

The detailed study of this book will interest any one at all acquainted with the curious structure of this pyramid, the greatest of Egypt's great wonders. So much information has been collected, and so wide a range of scholarship has contributed to it, that there is little wonder that it has received general attention in the past. The appendices, which are mostly new matter, bring these observations down to the present year. And the book, as a whole, gives probably the best and most complete knowledge of its theme to be found in print anywhere.

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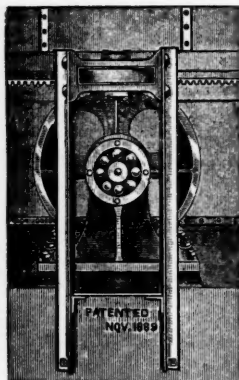
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